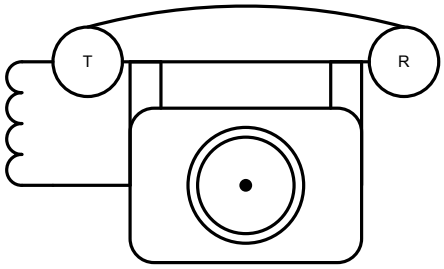
Old Telephones



Building Telephone Testers and Learning How to Use Them

Common Battery Telephones

Level – Intermediate to Advanced

oldphoneguy

Colin T. Chambers

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Old Telephones

WEB EDITION

Building Telephone Testers and Learning How to Use Them

Common Battery Telephones

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Written for fellow telephone collectors

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Version 2.1 WEB 022808

This document is divided into three sections:

Section One – The Basics

Section Two – Theory and Technical Explanations

Section Three – Reference Information

Old Telephones

Building Telephone Testers and Learning How to Use Them
Common Battery Telephones

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Introduction

Did you stumble across an old telephone at a garage sale or on EBay, maybe you found one in the back of your closet or in the basement? What's an old telephone you ask? It is one with a round dial that you put your finger in and turn, this is before the push button dial or Touch Tone® dial as it is usually called. The old phones are heavy and do not have a modular cord. Most of them are black in color. If you are like me, old and a bit gray or maybe you are all gray, you probably used telephones like this in your youth or you grandmother had one and you remember it at her house. The information in this book will help you understand old telephones and test them.

This book is about Common Battery Telephones, those that get their power from the Telephone Company Central Office. Local Battery Telephones are not covered in this book, they are the ones with the hand crank generators and they use dry cell batteries for their power.

I have tried to write this pamphlet in a simplified manner. I am going to save you all the detailed theory behind what I present here, look in the books suggested in the Reference Section for the theory.

Portions of this book are technical. Do not get discouraged, keep reading. The plot is simple but it has a large cast of characters.

Getting Started

First, read this entire document.

The second thing that might help is to get an old phone to test and/or repair. If you are first starting out get a Western Electric® Type 500 Telephone that has a good chance of working. This should cost you under $20, and you can later use the handset to make a tester. You might give it a once over with Fantastic© or at least Windex®. If you know the type number of the old telephone or manufacturer you can usually search the internet for a diagram so you can find out where to connect the line cord (Maybe terminals marked L1 and L2). I have included a diagram of a Western Electric® 302, one of the more common old telephones, popularly known as "The Lucy Phone" because it was used on *I Love Lucy* and will use that as the generic telephone to test. You will also need a standard telephone, a Western Electric® 2500 suggested, as your second phone (you will see why later).

If you can identify where the line cord goes, connect it to a telephone line and see if you can dial the phone, if the dial does not turn, just make sure it is at the "rest" position. Have someone call you, does the phone ring? Can you carry on a conversation? Do you hear noise or a frying sound? Is the other party clear? How is the volume level? The table on the next two pages should help you. If you can get the telephone to work, then clean it up a bit better. See the section Cleaning in Section Two.

> *Thomas Edison made the telephone practical by inventing the carbon transmitter, used in all old telephones. The Bell transmitter had acidified water was not too practical, and that's why he told Watson to "come here", nothing like acid on your pants to get your attention!*

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The Master Trouble Table

Symptom or Problem	Suggestions or Solution	√
Can't Find L1 L2 to connect line cord. Or phone did not work at all.	Do you have L1 and L2 for sure? Check the Internet for a drawing, look on the bottom of your phone to find any numbers and search the net.	
Phone works, but you can't talk	Bad handset cord, bad transmitter, contacts on back of transmitter are not touching or are very dirty.	
Phone works, but you can't hear.	Bad handset cord, bad receiver unit, contacts on back of receiver are not touching or are very dirty.	
Lots of noise, like a frying sound.	Bad electrical contacts need to be cleaned or bad transmitter.	
Phone works but you can't dial	Dial may need to be cleaned and lubricated, or check wiring (not likely).	
Phone works but does not ring	If you have yellow wire on the line cord, try connecting it to one of the other wires on the line cord. Do you have a tuned ringer? Test ringer separately.	
Handset cord missing or in bad shape.	If wires are broken, may not work at all. Add temporary wire for handset and re-test, you may need a wring diagram.	
Volume seems very low	Check connections and compare to the wiring diagram	
Nothing works no matter what I do	Perhaps you should start with another phone, if this is the first time you are doing this.	

When testing the phone take your time and do not get too concerned, at first if it does not work at all. Try to find the original diagram, there are many sources on the Internet. Check the wiring, if you decide to change something make a sketch on paper of the original wiring as you found it with any changes you made (perhaps in colored pencil). Patience is helpful, this should not be a high stress activity.

> *A good starting point would be your local Telephone Collectors group or try searching on the Internet. Start with -- http://atcaonline.com/. They have a great site, and support them by joining.*

Once you have found your problem, fix it. Now that's a simple statement. This is your hobby, take your time, do a good job, add the part you need, give the phone a final good cleaning, add a new line cord, and now you are all set. If your phone works and is not too dirty, it will take you an hour, if it is really in bad shape a day or a bit longer. Now you know why you see restored telephones on eBay for such high prices.

If you do not want to tie up your own telephone line for a long time, or have no friends to call you all the time to test, or no cell phone to call your wired line, then maybe you should build a Telephone Tester. There are two testers here that you can build. I would first suggest the one with the 9 Volt battery, the LED and the resistor. It is a simple tester, easy to use and will help you learn about telephones and read diagrams. The cost is about $7 at the most.

After this build "Tester Number One" you can consider building the more advanced tester. It will require a Telephone Key System Power Supply with a ring generator to make the ringer work. Search eBay under "Telephone Power Supply. This will set you back $25 to $50, they are heavy and shipping may be a few $$. Your total cost will be under $100 for the power supply and all the parts.

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Look in telephone closets with abandoned equipment in old buildings, yes there are still some around. Make sure the power supply is not being used and nobody wants it!

Think of this book as a class in old telephones and when you complete it, you can challenge anyone who says they know more!

It is almost this easy. I am the holder of two FCC registration numbers for reconditioned telephones. If I can do it, so can you. I cleaned up two old phones, tested them and paid a fee to have a professional engineer certify them, that easy!

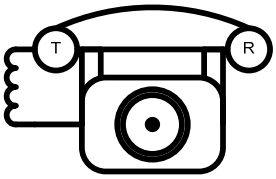
Here is the certificate, make a copy on nice paper and fill in your name. Alex invented the telephone, but it was not practical. Tom invented the carbon transmitter and made the telephone practical and in it's present form. The carbon transmitter has been used in millions of telephones.

This is to Certify That

_____

Has completed the course in old telephone repair and is now an

Old Telephone Certified Technician



Class Instructors

Alexander Bell

Tom Edison

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Telephone Pictures

There are hundreds of styles of old telephones and many variations within each type. Here are a few pictures for quick identification.

<<< External box needed with these telephones for induction coli and ringer >>>

Western Electric® 202 Stromberg Carlson® Candlestick Kellog® Candlestick Western Electric® 211

British Wall Automatic Electric® AE-40 Western Electric® 354 Automatic Electric® AE-50

British Desk Stromberg Carlson® Northern Electric® Western Electric® 302

Use the links in the XXX556xxx to look at additional styles, or you can search on EBay using “old telephones” or a similar search term.

These are more modern telephones:

Western Electric® 500

Western Electric® 2500

You can use one of these as your “standard” telephone when setting up your tester.

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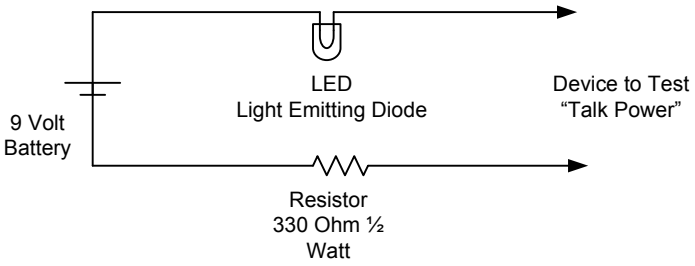
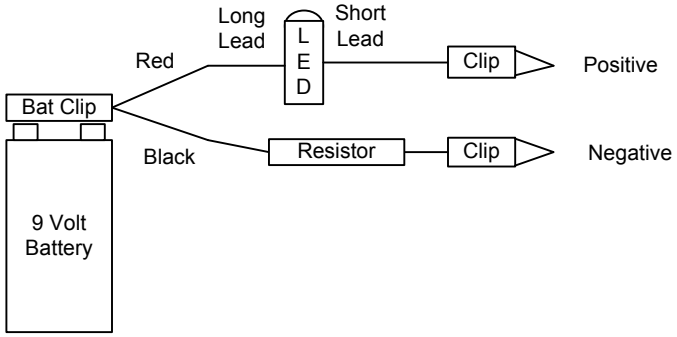
Simple Telephone Talk Tester and Continuity Tester





Parts List

9 Volt Alkaline Battery and matching Battery Clip
LED – Almost any type of LED will work
Resistor – 330 Ohm ½ or ¼ watt (Orange, Orange, Brown, Gold)
Clip Leads – Buy a package of 10 (you will use them later)

This is a simple tester and the battery life is not long, so do not use it for extended "talk" testing. If you substitute a small wall wart (those plug in power supplies) you will probably hear hum. The power supply is not the best, but it will work. If you use a 12 Volt or higher power supply, change the 330 Ohm resistor to a 680 Ohm resistor.

> *If you decide to use a wall wart (plug in AC Adapter), choose one with the highest Voltage (not over 28 Volts) you can find, use a 1,000 Ohm resistor (it will need to be a 1 Watt resistor for a 15 Volt or higher supply and a 1,200 Ohm resistor for a 24 Volt supply). If you have a lot of hum, when you try to talk, use another power supply. If you are very talented add a 2,200 mFd 35 Volt Capacitor for an additional filter. If you do not understand any of this, just use the 9 Volt battery.*

If your not really an "electrical" type of person, test everything you can with your new tester, light bulbs, toasters, TVs, Radios, try a 9 Volt radio (remove the original battery and use the tester as a source of power and see if the radio goes on and what happens when you reverse the leads on your tester), headsets (listen for the click), and so on. Just make sure everything is "unplugged" from its original power source.

> *Remember, do not test anything that has a power source connected to it!*

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You can use this simple tester to test a few things to solve any minor problems in your telephone.

1. Remove the receiver element from the handset, test it with the tester, you should hear a click in the receiver.

2. Remove the transmitter element from the handset, test it with the tester, the LED should light. As you sharply tap the transmitter with a pencil or bang it (hard on edge of the transmitter, not the front or the back) on the table, the LED should vary slightly in brightness.

3. Find the wires on the bell, usually only two wires, remove one of them from where it is connected and test the bell by connecting to the two bell wires, the LED should be slightly dimmer compared to shorting the wires on the tester. The bell coils have resistance and the current will be lower in the LED and it will be dimmer.

4. Find the pulse contacts on the rotary dial (the contacts that open and close once per number dialed), remove one of the wires connected to the dial and attach the tester to the dial contacts, the LED should stay on and when you dial you get one blink for each number.

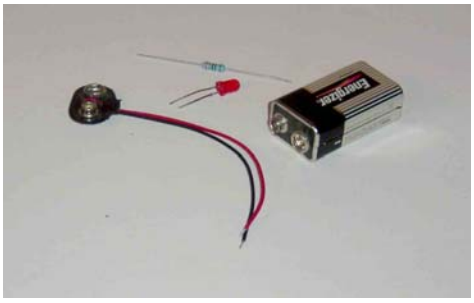
You soon see that a connection or short circuit or a piece of wire has continuity and if you test it the LED on your tester will show you the resistance (zero resistance on a piece of wire, perhaps 2,000 Ohms on a bell coil) by the brilliance of the LED.

If you test a Touch Tone® telephone, it may be necessary to reverse the leads of you tester to make the telephone “tone”. Some early models of this telephone did not contain a polarity guard. The current (power) that this tester applies to the telephone is limited, and you may not get full tone volume.

You can tape the LED and resistor to the battery using electrical tape, make sure you tape the connections on your tester so they do not short out on the metal case of the battery. This makes an ideal pocket tester to carry with you to garage sales and swap meets to test all those old phones you are going to buy.

With the leads shorted together or testing telephones, battery life will be about 10 hours. Store the leads by clipping them on a small 25 cent size piece of cardboard. (Cardboard is an insulator if you keep it dry.)

These are the parts you will need: (Clip leads not shown)



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The above picture shows the completed version. Black electrical tape acts as the “case”. This is a simple tester and is small enough to carry it in your pocket.

Telephone installers use a device similar to the one you just built, it also contains a tone generator and a short modular cord. Usually it is in a small yellow plastic case about 3”x 3” x 1 ½”. Look on e-Bay under “telephone tester or cable tester”. An advantage of the little yellow box is that it also contains a tone generator that is used to trace cables. Sometimes paired with this in the same package (if you get a new one) is a small hand held amplifier to aid in the tracing of wires. The pair of them can be obtained for about $35 to $50. The original brand name is Progressive but now there are imports

This pair of a tester and an audio probe sells for about $35 to $50 on EBay.

Test Handset

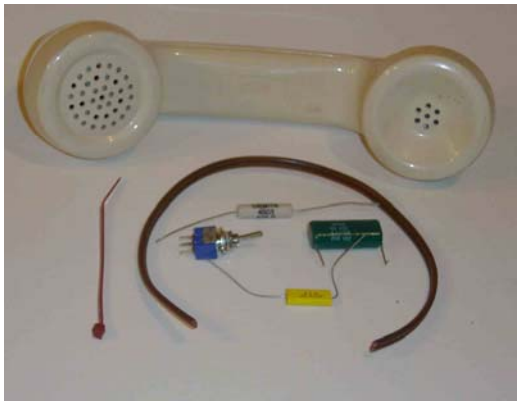
Now it is time to construct your test handset. This is just like a real ”lineman’s” test set, but without the dial. For this you will need the handset from a modern telephone (with a hollow handle), a 200 Ohm 5 Watt resistor, a 1 or 2.2 MFd capacitor rated at 200 VDC, a .1 MFd capacitor rated at 250 VDC and a small single pole switch. A piece of regular power line zip cord, several tie wraps and 2 alligator clips. Purchase a set of 10 clip leads at Radio Shack or another electronic store and re-use the clips.

The original of these used for many years was the Western Electric® 1011A test set in the black rubber case with the strange dial. There were probably tens of thousands of these 1011A’s made. The plastic case one with the clear dial is the vastly improved version. Sometimes you can find a updated plastic version on eBay. If you find one like this buy it for about $10 to $15 (the color varies depending on the Bell System company it was used at):

“Bell System” w/ Test Adapter

DO NOT get the Harris Dracon® or any updated one, it has an electronic circuit inside, you want one with just a receiver, transmitter and a resistor/capacitor/coil for the “network”. The plastic Bell System one also has a special monitor circuit that works well. You cannot use any of these on a telephone line that has DSL on it, unless you use a DSL Filter.

This picture is all the parts for the one you are going to build.



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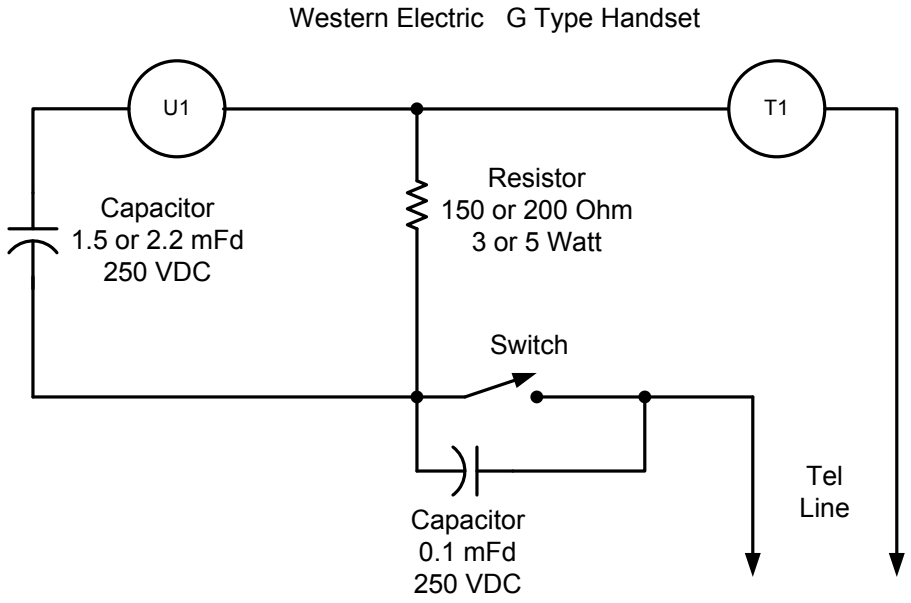
Telephone Test Handset #1



Getting all this in a hollow handset it a bit of a trick. It is more of a test or your visualization skills, especially mounting the switch, so it will not hit the U1 receiver. You can use either value capacitor, 1 mFd or 2.2 mFd, just depends on which one you get and which fits inside. The 2.2 mFd is the better choice.

For the line cord, use some flexible zip cord (AC Lamp Cord, two parallel wires, 18 gauge). Tie a knot in the end of the cord that goes in the handset to hold it in and a knot about 1 foot from the end where the clips are or use a tie wrap to prevent it from unzipping.

You can dial with this device, you just need to operate the switch at the dial pulse rate of 10 pulses per second, not an easy task. You will probably break the switch after a bit of time so only use this to dial when in a situation like you see in the movies.

> *You engineer types are probably thinking you could add a small push button switch to dial with, well forget it, those small switches are of very poor quality and do not last. And just try to push it a 10 times a second and get the timing right, new digital central offices have tight standards on dial pulses!*

If you are somewhat talented you can build the advanced tester version and add two LEDs to show you the polarity of the telephone line. The LED circuit can also be added to the Bell System one you purchase. Again, it will be test of your mechanical skills.

The capacitors used are non-polarized. Usually this means a mylar capacitor, NOT an electrolytic.

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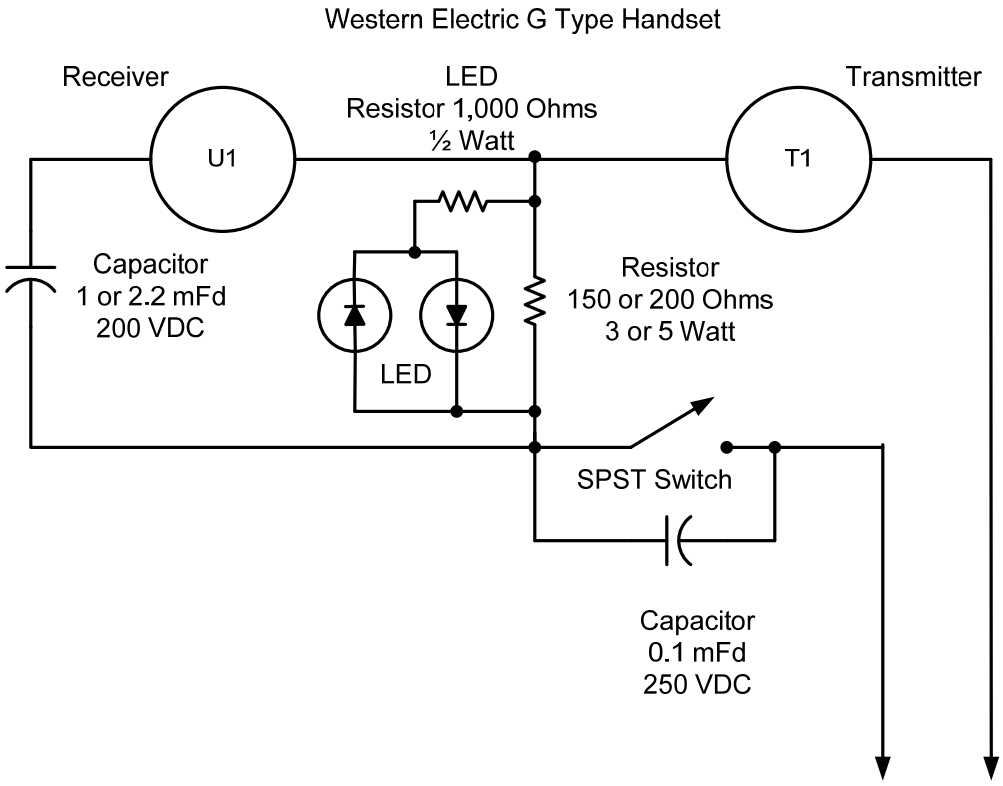
Telephone Test Handset #2 – Basic with LED's



The LED's will show you that you have DC (Power or current flow) present.

Learn how to use your test handset (either type) in the following ways:

1. Place it across your own home telephone line. With the switch on you should be able to talk and listen just like a regular telephone.

2. With the switch off, you can monitor the telephone line. This is not to listen into a telephone conversation (that could violate the law) but only to determine if the line is in use or if the quality of the call is bad. Listen to the telephone line when it is ringing in the monitor position.

3. Unscrew and remove the transmitter cap and unit of a good telephone, one with a carbon transmitter, turn on the switch and place the clips to substitute for the transmitter You will be able to "substitute" for the transmitter and to talk like normal, what you hear is not important, you will hear your voice in the earphone of your Test Handset. This will verify that the phone you are testing works fine and if the original transmitter was noisy, it will now be clear. If the original transmitter was bad, the phone will now work.

4. Unscrew and remove the receiver cap and unit of a good telephone, turn on the switch and place the clips as to substitute for the receiver. You will be able to "substitute" for the receiver

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and hear the other party on the telephone. This will verify that the phone you are testing works fine and that the original receiver unit was bad.

5. Connect the 9 Volt Battery Tester to a good telephone. Connect your Test Handset to the same circuit. Both phones should work, if you have the switch on you can talk and hear on both telephones, the volume may be weak, the current available with the 9 Volt Tester is small and this is normal. If you turn off the switch on your Test Handset you will monitor the circuit and you will hear the other phone when someone talks into the handset or hears clicks when someone dials. If you are using a Touch Tone® telephone, the tone dial may not work on the limited current available from the 9 Volt Tester.

6. With the switch in the off position (monitor), listen to the hum (or noise) on a wall wart that is rated at 12 VDC or less. Turn on the switch for a moment and your will be able to talk to yourself.

Do not leave the test handset connected to a regular telephone line and try to use it as an extra telephone, the monitor position represents about 1.2 miles of telephone cable on your phone line and the volume of your regular telephone will be less. If the phone company tests the line they may see trouble.

To be a super telephone repair person use your Test Telephone frequently and read Principles of Electricity as Applied to Telephone and Telegraph Work, published by AT&T. This may lead to a career change. I built my first test handset in 1957 and I read the 1961 edition of that book cover to cover several times and I retired as a Telecommunications Voice Network Design Engineer, and you can too.

The completed Test Handset
Note the Switch near the receiver end of the handset. LED's are not on this model, LED's mount in the back handset, behind the receiver.

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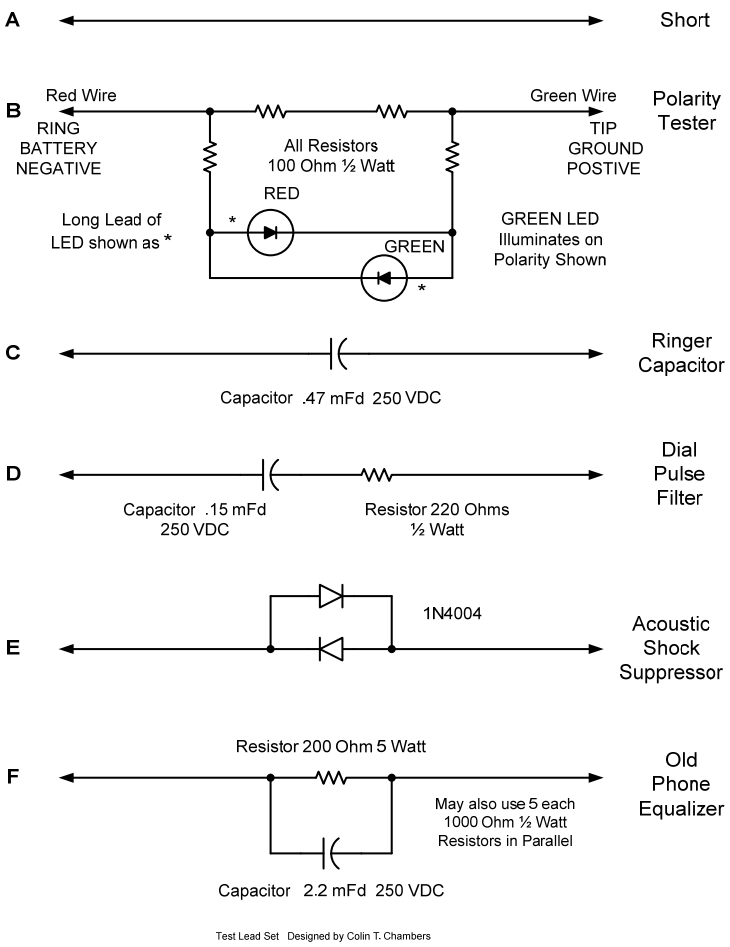
The Magic Test Leads

This is a set of test leads you will make up for testing old phones and finding out if some changes are necessary. You can use these test leads with a tester like the one in this book or when testing the old telephone on a telephone line.



These test leads are explained in detail in the next few pages. They are not absolutely necessary but may help you solve some problems.

Purchase of a set of 10 test leads in a package at Radio Shack, or just about any electronic store, and the parts shown in this section. When you make the 9 Volt Tester use one of the leads for the clip leads (or two if you want long test lead on the tester). With the remaining test leads make up the ones shown.

The parts, resistors, capacitors, diodes and LED's should be available at your Radio Shack, if not look at one the sources listed in the Links in Section Three.

> *NONE of the leads may be connected to any power supply, they may short out the power supply or the test lead may melt or explode in your hands.*

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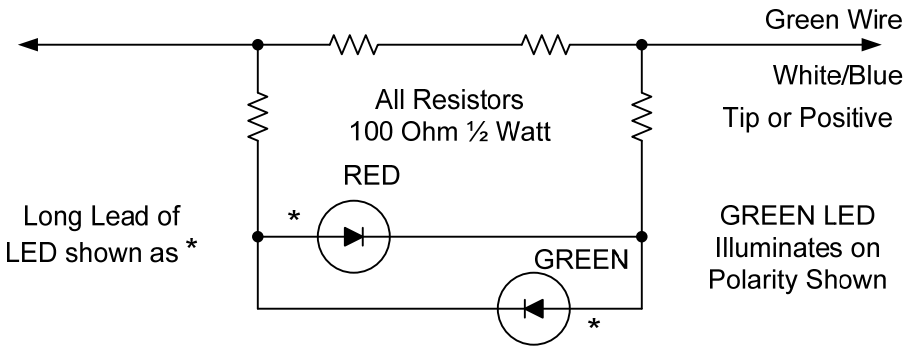
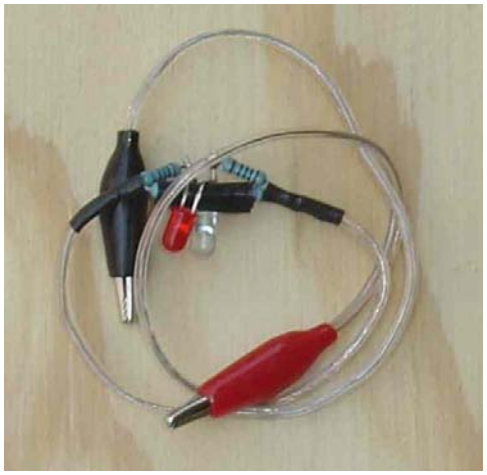
Constructing the Test Leads

:

Lead A – Just a plain jumper wire – If you think one of the wires in the old telephone is missing or bad, substitute the plain jumper wire to find out. Also useful when the old line cord is cut off and you want to make a temporary connection to test the old telephone.

All of these leads are constructed using a set of clip leads. These are typically sold 10 leads for about $3.95 or so.





Lead B- Telephone Line Tester, Polarity Indicator for Telephone Line – You can test a standard telephone line and find the tip and ring or battery and ground. The green LED lights when you have it correct connected, the red LED lights when you have it reversed. If you thought a carbon transmitter was noisy, remove the transmitter and connect this lead in it's place. One of the LED's will glow and if the noise goes away the transmitter is noisy and can either be replace or banged sharply on a hard surface a few times to break up the carbon. Bang the transmitter on the edge and not the front (part with the holes) or back (part with the contacts). Repeat this several times and then re-test. In old transmitters the carbon sometimes need to be loosened up. If this does not work, replace the transmitter unit with another one.

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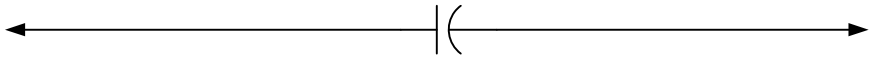
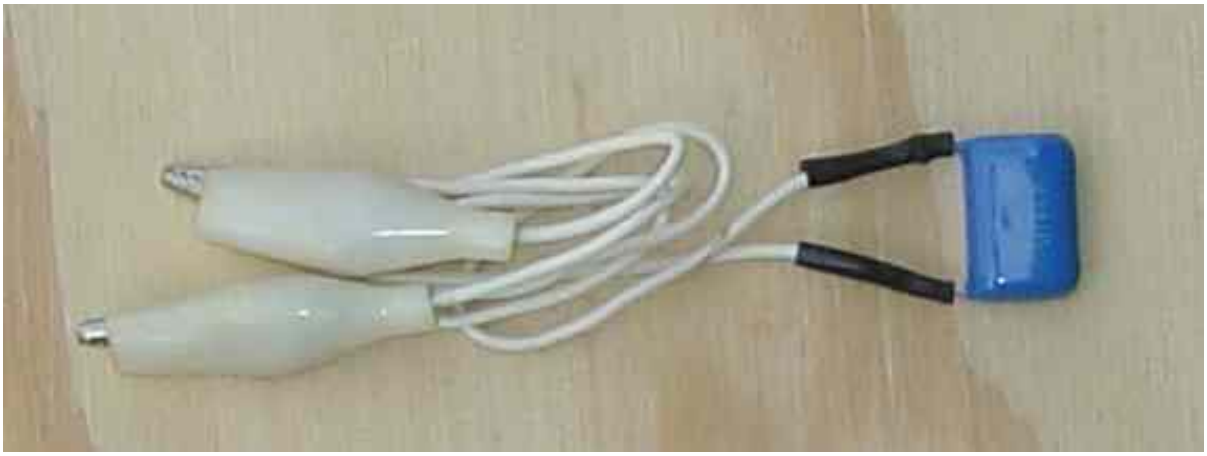
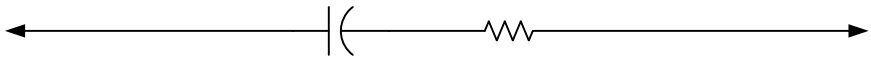


Capacitor .47 mFd 250 VDC



Lead C – Ringer Capacitor, standard value for a modern ringer – If a ringer capacitor is missing or defective try using this lead to test with and see if the bell rings. If the ringer REN is 2.0 or above, try replacing the ringer capacitor with this one, see if the bell load is reduced and if the bell rings ok. You may need to adjust the gongs and/or ringer spring for the loudest sound.



Capacitor .15 mFd
250 VDC

Resistor 220 Ohms
½ Watt

Lead D – Dial Pulse filter, eliminates radio interference with dialing or “bell tinkle” – If you hear your old telephone dial in the radio or it causes lines on your TV or the bells in any of the phones on your regular telephone line tinkle or tap the gongs when the old telephone is connected to this line and you dial, then you need this filer across the dial pulse contacts (these open and close once for each digit you dial).

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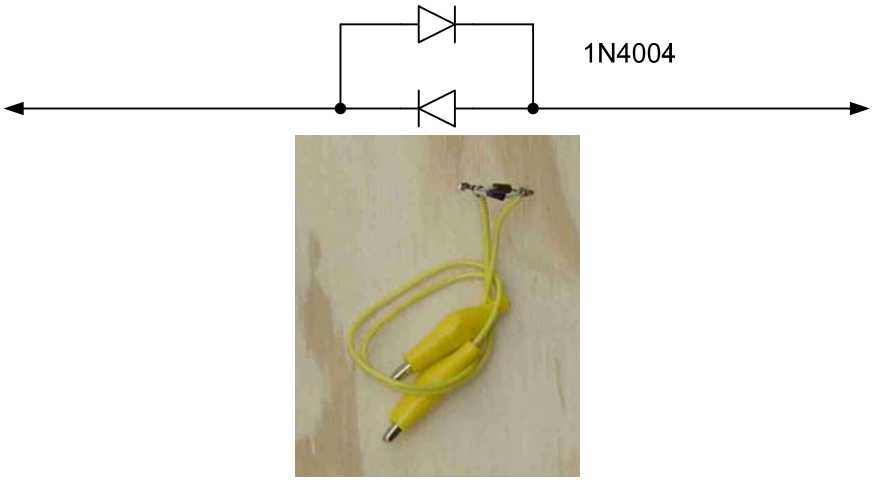
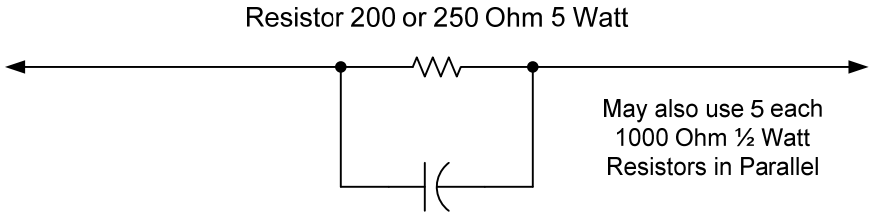


Lead E – Acoustic Shock Suppressor – reduces volume of clicks in receiver – Loud clicks or pops in your ear can be annoying, this is NOT included on old telephones, it IS on 500 Telephone Sets and later models. Try connecting this across the receiver terminals (easiest to try at the base where the handset cord connects to the set) and test by rapidly disconnecting and re-connecting your telephone set from the telephone line or the tester, the clicks should be greatly reduced with this in place.



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Lead F – Old Phone Equalizer – put in series with old phone to reduce current – On an actual telephone line connect your old telephone and then a modern telephone try to use both of them at once, does your old telephone “suck out” all the power. If so put this in series (remove one side of the telephone line from your telephone set and connect this between the old telephone and the telephone line) and try again. This should equalize the power to your old telephone so it is shared between the two set and not hogged by the old telephone.

You should try leads B, D, E and F and see if there is an “improvement” in your old telephone. Lead C only needs to be used if the REN (Ringer Equivalence Number) is over 1.5. If you have a Western Electric® 200 (Oval Base) telephone or similar telephone of this vintage you probably need this especially if you have an “older bell” where the capacitor on the coil functions as both the ringer capacitor and the sidetone capacitor.

Experiment! That’s how you learn. Using the 9 Volt battery tester, the test handset, these leads and a working telephone, try everything. Nothing will burn out or explode, and you cannot harm anything. Once you test everything on a working telephone your knowledge base will be greatly improved and you can begin to test an older or non-working telephone and find the parts that are bad or the failures in items like the hook switch or a receiver capsule.

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Adding the Necessary Items

Now that you have used “Telephone Test Handset #1” and the Magic Test Leads, you should have determined which items to add to your telephone. At the minimum add the acoustic shock protector across the receiver. Add the old telephone equalizer, this can be added in the mod jack on the end of the new cloth line cord or in the telephone set itself.

To do the minimum:

1) Mount two diodes (equivalent of Lead E), 1N4004, across the back the receiver unit, usually these will fit in the handset, if not install them in the telephone base.
2) If you have an old telephone and want to use it on a telephone line with another modern telephone, add the resistor/capacitor combination (equivalent of Lead F) at the modular jack or in the telephone set.

Now your telephone should be in good working order, perhaps adding a final polish of paste wax and packaging the handset and base in plastic bags will be the finishing touches. Probably as soon as you polish it, you will want to use it and not pack it away.

Properly re-conditioned old telephones are the “in-thing” now. Look at the reproductions, with the phony rotary dials and buttons substituted for holes.

This telephone shown below was on EBay for just under $200. It has a good professional polish (you can do that too with a little elbow grease). You could do this and then give it away to friends, sure beats a fruit basket.

Western Electric 354

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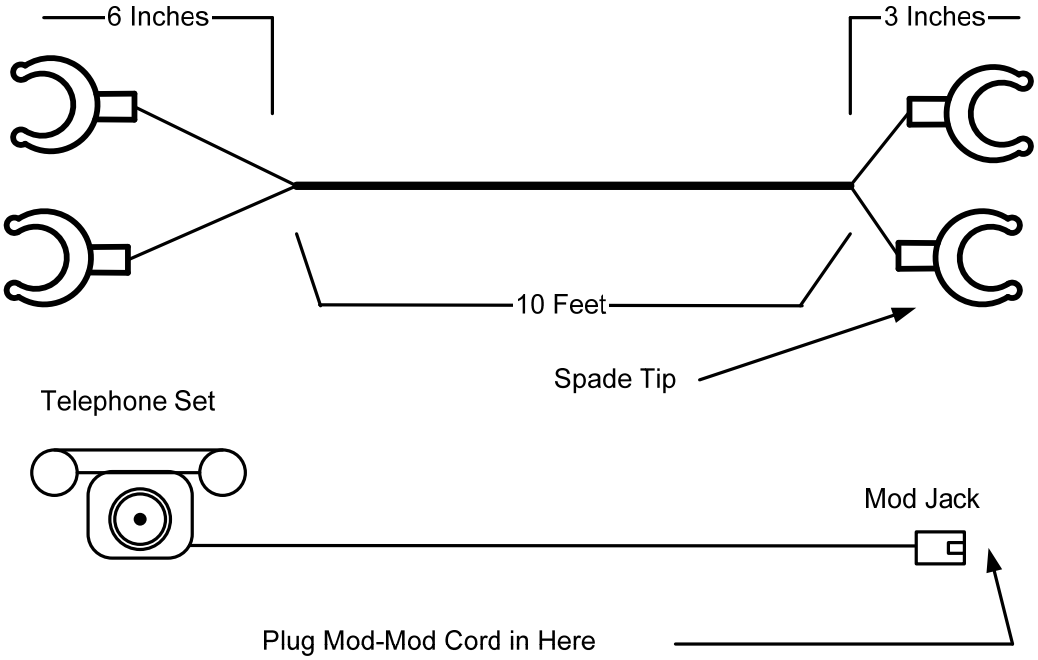
Cloth Cords

If the old telephone has cloth cords they may be in bad condition. There is little that can be done to repair cloth cords. If it is a simple frayed outer covering in one or two spots you might try wrapping the cord with brown thread, that's about the only remedy.

Replacement cords are available and are not too expensive. I suggest Phoneco for cords and parts (http://www.phonecoinc.com) they have been in business for many years.

A suggestion, the modular cloth covered line cord is just that, a standard modular line cord covered with cloth. Personally I do not like it, too stiff for my likes. For my old telephones I use a 2 conductor cord that I have Phoneco make up. I order a 10 foot, 2 conductor cord, like that used on an old receiver on a wooden phone, with one end 6 inches of separation and the other end 3 inches of separation with spade tips on all ends. I attach a modular jack (yes that's right a jack) on the 3 inch end and then put the 6 inch end inside the telephone set. I find the mod clips on the cloth cords can come off or the tab breaks. I just attach a 7 foot mod to mod cord to the jack and …. It becomes a standard line cord.



By doing this, the mod – mod cord can be easily replaced if the tab breaks or you need a longer cord, and the cloth cord is somewhat more flexible and more "original" looking compared to the cloth "covered" plastic mod cord.

Handset cords can ordered or made up for the specific handset or telephone set you have. Look in the Phoneco Catalog.

Tie wraps can be used inside the phone or handset to anchor the cord if needed.

Automatic Electric® handset cords can be more difficult to find, they are the 4 conductor (but only three conductors are used) braided type. If you are up for a challenge, you could order three

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individual cloth cord conductors, about 3 and ½ feet long or longer if you want a long handset cord (I prefer to start with 4 feet) with spade tips on each end and braid them yourself, it is not quite original, but just close. If you want a real challenge order 4 cord from Phoneco, separate out the 4 conductors and braid them with a piece of brown elastic cord in the middle. You can dye while elastic with Rit® dye and do it that way. To “close” the ends of the braid, use dental floss wrapping about 10 turns around the end, tie a knot and put a drop of clear nail polish on it to hold it closed. The elastic should be anchored in the dental floss wrapping, extra nail polish will help hold it in place.

It is possible to order the cloth cord in bulk and make your own cords, but attaching terminals the proper way is only for the very talented and experienced. It does NOT work like a standard crimp terminal. Most of this wire is of the tinsel type, a flat conductor wrapped around a piece of cloth and cannot be easily crimped or soldered. Phoneco has the spade tips if you want to try this. It takes a special tool to do this, not the standard crimp tool.

It is best to order the catalog from Phoneco, study it, and look on line at the types of cords available. I highly recommend them for any parts you need.

A mod-mod cord is a telephone cord with a modular plug on each end. This is the standard line cord on a modern cord.

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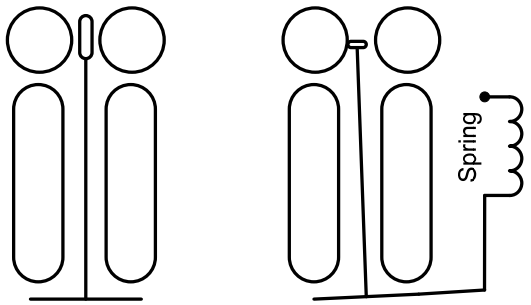
Tuned and Un-Tuned Ringers

Study the drawings and note the differences:



Tuned Un-tuned

This is representative of ringers in old telephones. Ringers are of two types “Un-Tuned” or standard ringers that operate on 20 or 30 Hz and “Tuned” that operate on a specific frequently. Your telephone set at home has an un-tuned ringer. Un-tuned clappers can easily be moved with your finger, tuned clappers appear to be “stiff”.

Tuned ringers were used on party lines by the Independent Telephone Companies to get up to 10 parties on a single telephone line. Each customer had a separate ringing frequency, two systems were used, Deci-harmonic and Non-harmonic. Deci-Harmonic ringing frequencies are, 20, 30, 40, 50 and 60 Hz, Non-harmonic ringing frequencies are 16, 30, 42, 54 and 66 Hz. In some cases the ringer capacitor is specific to the ringer. Names and exact frequencies vary slightly between manufacturers. The clapper is difficult to move by hand on a tuned ringer.

If you have a tuned ringer in your telephone, unless it is 20 Hz, it will NOT work on a standard telephone line. The clapper on a standard ringer is easy to move and has a simple spring adjustment.

The tuning is both electrical and mechanical. I have shown the clapper on the tuned ringer as longer, some are as short at a standard clapper. Most have an adjustment set screw on the clapper for fine tuning. Also tuned ringers do not have an adjustable spring. Only un-tuned (standard) ringers have an easily adjustable spring. Note that on the un-tuned ringer the clapper rests on one of the gongs or close to it. Bell tinkle or bell tap is when you dial an old phone and the bell makes a very slight noise, try adjusting the gongs or the spring to eliminate this.

If you have a tuned ringer you will need to replace it with a standard ringer, you may need to get one from a junk set that you are scraping for parts. You may also need to replace the ringer capacitor. It may be possible to mount a ringer from a “Trimline®” or similar “dial in handset compact” telephone in the case, while not authentic, it will ring. Be sure to use a .47 mFd 250 Volt ringer capacitor.

If you are lucky and get a 60 Hz ringer you can remove it from the telephone, along with the capacitor if it is specific to the ringer and power the ringer directly from the power line (60 Hz), just attach an old AC cord and plug it in (entertainment). If you have one with a 66 Hz ringer, adjust the set screw on the clapper, place it closer to the end of the shaft it is mounted on, and it will also work on the power line (60 Hz). Other frequencies ringers will not work this way, but the clapper may have some sort of odd oscillation, if you leave it in the phone and try and use it, but the swing will not be enough to strike the gongs. Caution: The 120 Volt Power Line can shock or kill you!

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Understanding Battery Feed

Before starting construction of the testers, it will be helpful to understand some of the theory behind what your building.

DC current (Battery) is needed by the carbon transmitter to make the phone work. The way the telephone company does things is to feed battery to a telephone line using a device that allows the DC (Direct Current) to flow but does not “short out” the AC (Alternating Current) or voice as it is called in telephony. The voice can also be called the audio, the talk path, speech or something like that.

How is this done? In the 9 Volt Tester a resistor was used, this limits the DC (current) flow but it also tends to reduce the voice (audio) because the resistance is low and is the same for DC and AC (voice). The device that allows DC to flow but offers a greater “resistance” to voice is an inductor. A coil of wire has an inductance and impedance.

An inductor in telephone work is a coil of wire with an iron core. This has Impedance on AC. If you took several nails and put 200 feet of copper over them, like maybe you did in school and made an electromagnet, several principles apply. If you connect this to a battery, you get a magnet and current flows from the battery. If you took a meter and measure the “DC” resistance it might be 10 Ohms. But if you used this same coil on AC it has both resistance and reactance (this is going to get complicated, you might want to skip this section until you get your electrical engineering degree or you read that AT&T book) and this combination is called Impedance. A wild guess would say that at the power line frequency this might be 40 Ohms. If you used this at voice frequencies, say to feed battery to a telephone circuit that Impedance might rise to 200 Ohms.

A Telephone has an impedance of between 600 and 900 Ohms. To feed battery you need an inductor that allows DC to flow, typically about 35 milliamps (.035 Amps), and has an impedance of several times the impedance of the telephone so as to allow the voice (audio or speech) to be unaffected. For a coil this means about 5,000 Ohms impedance or more at voice frequencies.

For you engineering types, the line losses (cable resistance and such) must also be considered but I am going to leave much of this out of the discussion, it ouit os the scope of this book. I am also not going to cover loading coils, but then you probably have a DSL line so those are not used. For more explanation on this purchase “*Principles of Electricity and Electronics as applied to Telephone and Telegraph Work*” by AT&T.

After taking the above cirteria into consideration a simple 24 Volt DC relay (RLY) meets these requirements. It has a DC resistance of about 700 Ohms and allows about 30 milliamps of current to flow at 24 Volts, adequate for talk power or current, and an impedance of. … well it is about right. (Finding that relay may be a problem so in the testers shown here, a 12 Volt 400 ohm relay will be used and a resistor will be added to equal about 700 Ohms on 24 Volts. This relay is easily obtained at any Radio Shack Store, Type Number 275-248A.)

Connect a 24 Volt DC relay (RLY) to a 24 Volt DC power supply and feed battery to your old telephone and that’s it. The power supply of choice is a 1A2 Key System Power Supply. Typically this has 24 VDC Talk (filtered, no hum), 24 VDC Signal (unfiltered) and 10 VAC. If your going to build the more advanced version, you will need one of the supplies with a Ring Generator, usually 30 Hz. Sources for this are eBay or telephone closets in large buildings as the supplies are often abandoned when the systems are converted to Electronic Key Systems, or garage sales or swap meets.

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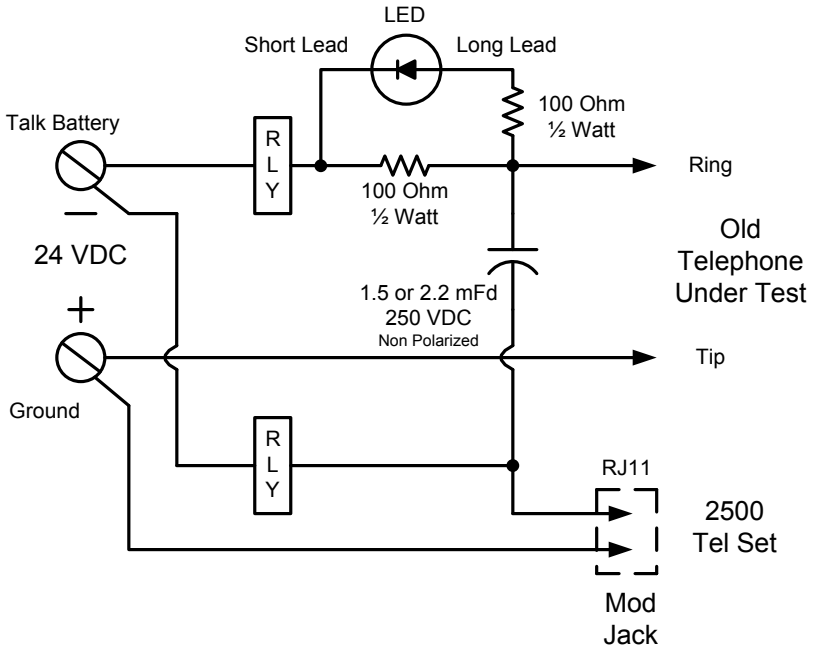
Lacking all this, you can try a 24 VDC power supply, but it will probably have hum or noise that you will hear in the phones. See Section Two, Adding a Power Supply Filter, to remove this noise. Switching power supplies may not work well without a connected load (use a 500 Ohm 3 Watt resistor) and a filter. Also see the QD Testers in Section Two.

Typical 24 Volt 700 Ohm Relay
Contacts 4 Pole Double Throw (4PDT)

Basic Battery Feed Tester With 24 Volt 700 Ohm Relay



Relay (RLY) contacts are not shown. Relays are 4PDT, 650 or 700 Ohms.

You can leave telephones connected to this and off hook, as long as you like. When a telephone is off hook, the relay associated with that telephone will operate, if you dial with a rotary dial the relay will click as you dial. It may be necessary to slightly bend some of the relay contacts or adjust the relay spring to make it operate and release as you dial the phone and as you go on hook and off hook.

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Each time you go off hook on the old telephone the LED will light, it will blink when you dial.

With a telephone connected, wiggle all the wires and listen for noise, if you find a loose connection tighten the screw. If you find a bad wire, replace it. If you find a dirty contact clean it.

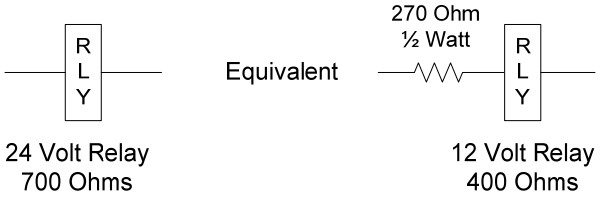
Don't worry about adding a long line cord or two or three, the tester will still be functional with hundreds of feet of line cord.

Leaving the 2500 telephone set off the hook when testing the old telephone will have no effect. It may be possible to use a speaker phone type of set for the 2500 telephone set allowing you hands free testing. Some types of speakerphones may not work this way, but perhaps you can find one that will. This makes an easy way to listen for noise by wiggling things and listening for noise or noise when you operate the hook switch (should just be a single click), put the speaker phone on mute and turn up the volume so you can hear all the noise. Some older 2500 telephone sets did not have a polarity guard, if the tone dial does not work, reverse the leads on the mod jack.

Happy testing!

Substituting a 12 Volt Relay

This is a 12 Volt 400 Ohm Relay, Type Number 275-248A from Radio Shack. Similar relays are available from surplus parts dealers listed in the Reference Section. It must have a resistance of close to 400 Ohms. To use this in the 24 Volt design use this relay and a 270 Ohm ½ Watt resistor in series. This will substitute directly for the 700 Ohm 24 Volt Relay, if you cannot find the 24 Volt relay.



Relays that are rated at 24 Volts will generally work from 20 Volts to 30 Volts without a problem.

The 24 Volt Complete Tester

This is a more challenging project. It will also allow you to test the ringer in the telephone and to determine the REN (Ringer Equivalent Number). Caution, the ring generator can shock you, watch your fingers because the ringing voltage can cause a “bite.”

> *Telephone ringing Voltage is not considered too dangerous, it will give you a nasty shock. USE GREAT CARE when working with ringing Voltage. One hand in your pocket at all times, making wiring changes when the power is OFF, use the same kind of precautions as you would around Voltage found in your house wiring.*

A 1A2 Key System is the old style bushiness phone system that that push button switches on the front of the phone at the bottom. They were used in most small to medium sized business prior to electronic key systems. In telephone terminology a “key” is a switch.

This is an example of Telephone Power Supply with Ring Generator used on the 1A2 Key Systems:

1A2 Key System Power Supply

Western Electric
20C4 POWER UNIT
INPUT 105-129 VOLTS 60 HZ 130 WATTS
OUTPUT DC TALK 18-26 VOLTS 0.6 AMPS
SIG 20-26 VOLTS 1.5 AMPS
TOTAL 18-26 VOLTS 1.5 AMPS
60 HZ 8.75-11 VOLTS 4.5 AMPS
OR 16-20 VOLTS 1.4 AMPS
30 HZ 110-125 VOLTS 0.06AMPS
LISTED 7878
TELEPHONE POWER SUPPLY

Typical Name Plate

These come in many shapes and sizes. Look at the name plate to be sure it has ringing Voltage. The name plate show has 30 Hz at 110-125 Volts with a current rating of .06 Amps, that is enough power for 6 standard ringers.

You are going to use the “DC Talk” and the ringing Voltage for your tester. The other Voltages are not used, unless you want to connect indicator lamps to the relay contacts.

Oh, if you are wondering what happens when you blow the flat fuse on the 24 Volt or 10 Volt part of the power supply and you can’t get replacement fuses, no problem. Get a new modular cord and use ONE of the individual strands in ONE of the wires. Usually there are 7 strands of individual wire in each of the conductors in the cord. Carefully remove the stand, and put it under the screw terminals. It will provide short circuit protection.

You may use power supplies by any manufacturer if the Voltage is 24 Volts DC with filtered talk battery and ringing Voltage with either 20 or 30 Hz.

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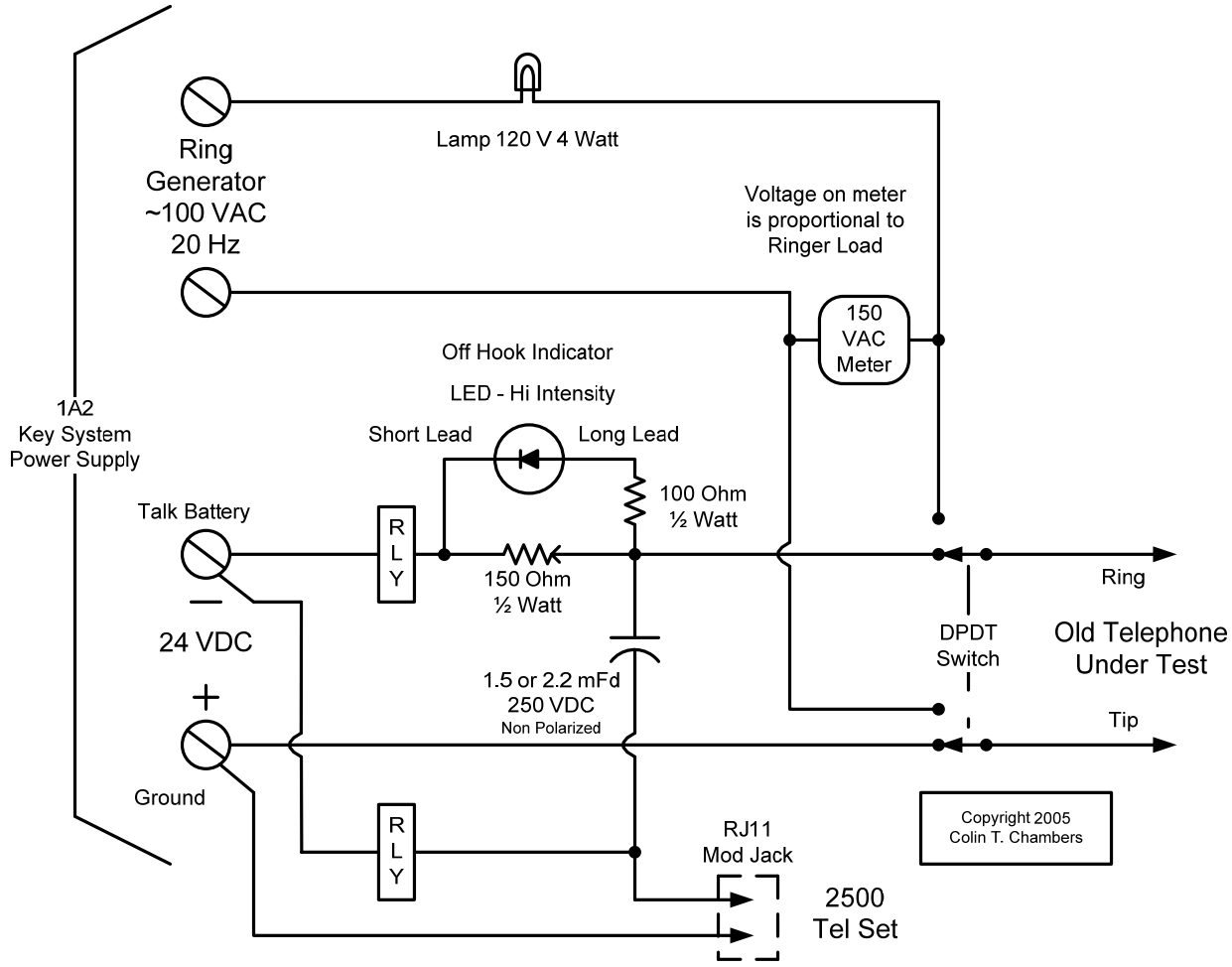
Schematic Drawing



RLY - Relay is 24 VDC Relay with resistance between 600 and 700 Ohms
1000 Ohm resistor in series with capacitor may be used to simulate “phone line loss”

Advanced users may wish to wire the contacts of the relays to provide off hook lights using the 10 VAC on the 1A2 power supply and 12 Volt lamps. Automotive lamps, like the add on ones with a nice red lens at the Auto Parts stores work great. Use the smaller lamps, the large ones have a heavy current draw and will fry the relay contacts in a short time, it is also better to parallel the relay contacts if you use the auto bulbs.

There is no ring back tone with this circuit. So you will hear nothing in the 2500 tel set when you apply ringing to the old phone, just a click when you operate the DPDT switch.

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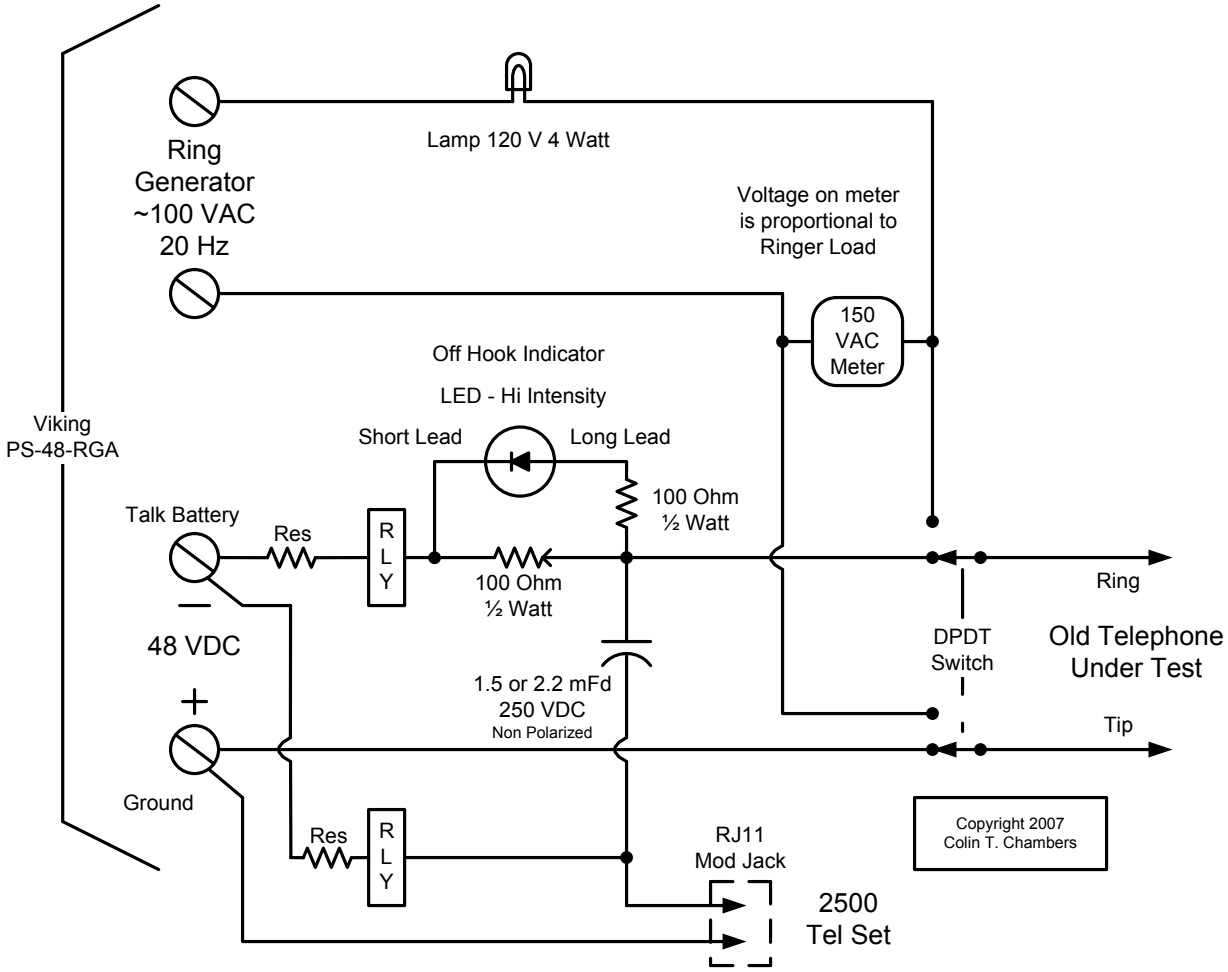
The 48 Volt Complete Tester

This uses a commercially off the shelf power supply (www.vikingelectronics.com). It is true 48 Volts DC and true 20 Hz ringing. The cost of PS-48-RGA is about $125.



RLY - Relay is 24 VDC Relay with resistance between 600 and 700 Ohms
Res - Resistor 500 Ohms 3 Watt or 470 Ohm 2 Watt

The only difference between this and the 24 Volt version is that this uses 48 Volts DC and the 20 Hz, this is equal to what is used at the Telephone Company Central Office. Because the Voltage is higher a resistor must be used to lower the current, a value of 500 Ohms has been chosen, any value between 470 Ohms and 600 Ohms will work. The resistor must be rated at 3 watts.

You play place a 1000 ohm ¼ or ½ watt resistor in series with the 1.5 or 2 mFd capacitor. This will cause some “loss” of audio between the two telephones and simulate an actual connection.

Viking Electronics sells these supplies. http://www.vikingelectronics.com

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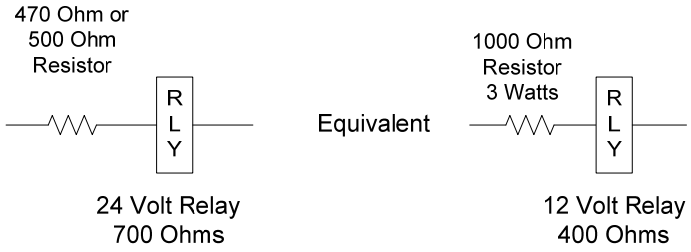
Substituting a12 Volt Relay

This is a 12 Volt 400 Ohm Relay, Type Number 275-248A from Radio Shack. Similar relays are available from surplus parts dealers listed in the Parts Sources and Links Section. It must have a resistance of close to 400 Ohms. To use this in the 48 Volt design, use this relay and a 1000 Ohm 3 Watt resistor in series. This will substitute directly for the 700 Ohm 24 Volt Relay and resistor if you cannot find the 24 Volt relay.



For the 48 Volt version, the 24 Volt 700 Ohm relay and the resistor is the preferred design.

Here is a picture of one type of ringing generator that is very common. There are still thousands of these abandoned in telephone closets. There were once used for business telephone systems, the 1A2 Key Systems. If you have a power supply with only DC and no ringing you can use this for the ringing power. If you build a QD (Quick and Dirty) Power Supply you can use this Ringing Generator. In testing standard ringers, 20 or 30 Hz makes little difference.

Western Electric – 118A Frequency Generator
105-129 V 60 Hz In - 110 V 30 Hz Out

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A Word of Caution

Ringing Generators and Telephone Lines produce Voltages that can cause an electrical shock. Wet hands, standing in water or on a wet ground can increase the intensity of the shock. Your reaction to this shock could cause you to fall or move into something that could harm you.

Old telephones may have one side of the telephone line connect to the metal parts of the telephone, this could be dangerous and result in a shock.

Anything suggested in the book should only be attempted if you feel confident in avoiding electrical shock and in taking the necessary precautions to work safely and to produce a restored telephone that is free of electrical hazards.

Use caution when working with chemicals to clean an old telephone.

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Section Two – Theory and Technical Explanations

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Trouble Shooting Matrix

Can't Find L1 L2 to connect line cord. Or phone did not work at all.	Do you have L1 and L2 for sure? Check the Internet for a drawing, look on the bottom of your phone to find any numbers and search the net.	

Terminals should be marked, L1 & L2, or LINE. If not, look for two screw terminals that look like they have been used several times. Use your tester and try all the combinations, you will not harm anything. Have you checked the Internet for a diagram? There was a wide variation of connections and re-wirings so even an original diagram may not match if the induction coil or ringer modifications were made.

Phone works, but you can't talk,	Bad handset cord, bad transmitter, contacts on back of transmitter are not touching or are very dirty.	

Most likely cause is a short in the transmitter wiring, a bad transmitter or a shorted coil. This assumes you have the right terminals for the telephone line. Take the transmitter out, in most cases this breaks the circuit, it if does not, check for bad wiring or a short. Also sharply bang the transmitter on it's edge, not front or back, to unpack the carbon granules. You can also test the transmitter by temporarily connecting to a good standard telephone, such as a 500 or 2500 in place of the T1 transmitter unit with clip leads (Type A). You can also substitute the T1 from the good telephone for the transmitter in the "bad" telephone. You can also use your Test Handset you built to substitute for the transmitter.

Check for bent contacts in the handset, make sure the contacts touch the transmitter and receiver elements when the caps are screwed on the handset

Phone works, but you can't hear.	Bad handset cord, bad receiver unit, contacts on back of receiver are not touching or are very dirty.	

Solve the problem similar to the way you did with the transmitter, expect for banging on a table. Use the U1 or U3 receiver unit to substitute temporarily for the "bad" receiver unit. You can also use your Test Handset you built to substitute for the transmitter.

Lots of noise like a frying sound.	Bad electrical contacts need to be cleaned or bad transmitter.	

To determine if it is the transmitter, remove the transmitter from the handset and replace it with a short piece of wire or Clip Lead A If the noise goes away it is the transmitter or the contacts in the handset. Fix the transmitter element as in A2, bang the transmitter element on a table to loosen up the carbon granules, bag it hard! Clean the contracts in the handset and on the back of the transmitter with a Q tip® dipped in ammonia and then wipe them with water and dry them. You can also use your Test Handset you built to substitute for the transmitter.

Phone works but you can't dial.	Dial may need to be cleaned and lubricated, or check wiring (not likely).	

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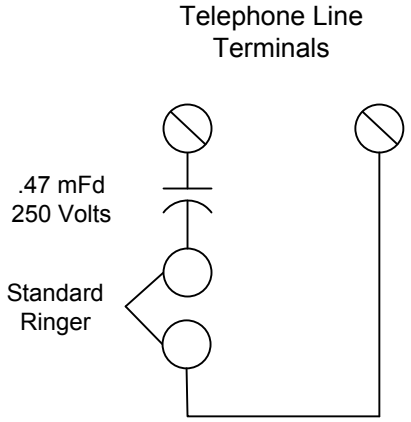
Not to common. Best to remove the dial if you think there is a problem and clean and lubricate it. Make sure you see one set of contact open and close once for each number dialed.

Phone works but does not ring.	If you have yellow wire on the line cord, try connecting it to one of the other wires on the line cord. Do you have a tuned ringer? Test ringer separately.	

Each telephone probably has 4 or 5 different possible ringer combinations. Test the ringer, this is the basic wiring:



You can connect this combination across a standard telephone line and have someone call you, or wire it in the phone this way and have someone call you. In very old phones the ringer capacitor may be a different value, it is best to use the ringer capacitor on Test Lead C for testing.

Handset cord missing or in bad shape.	If wires are broken, may not work at all. Add temporary wire for handset and re-test, you may need a wring diagram.	

Replace the handset cord with new a new one or use any wires for a temporary connection and test. Make sure you have the correct wiring, consult the diagram. If in doubt try all the combinations.

Volume seems very low	Check connections and compare to the wiring diagram	

Try replacing the receiver and the transmitter units. If the wiring is correct and the volume is still low the induction coil may be bad, this cannot be repaired. If the induction coil is out you may need to replace it from a scrap telephone.

Nothing works no matter what I do	Perhaps you should start with another phone, if this is the first time you are doing this.	

Save this phone for when you have restored several telephones and are more familiar with testing and repairing old telephone. Or just set it aside and get another telephone to repair.

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Cleaning Old Telephones – Outside Plastic Parts – General Information

What you will need:

Rags – but I prefer towels from the $1 store, wash them first
Heavy Duty Cleaner – Fantastic® or 409®, either work just as well
Super Heavy Duty Cleaner – Spray On Oven Cleaner, but test first before using ☠ Read the label, it is dangerous!
Automotive Rubbing Compound – use carefully, it can scratch
Rinse – equal parts rubbing alcohol and water with 2 drops liquid detergent per quart
Paper Towels
Cotton Swabs
Johnson's® Paste Wax – no substitutes here
A few drops of ammonia ☠ Read the caution label on the bottle!
Index Card
Lighter Fluid – caution, read the can ☠ Dangerous and flammable!
Light Machine Oil

After determining that the telephone is somewhat working you can clean it, if it is not working, get it working first so you do not waste effort cleaning a telephone that will never work.

Take the cords off the telephone, be sure to make an accurate drawing of what they connected to. Unscrew the receiver and transmitter caps and remove set the elements aside. If the buttons that control the switch hook come out, take them out. Remove the dial (separate cleaning instructions). Now you should be left with only the plastic parts.

Put all the plastic parts on a sheet of newspaper and spray with Fantastic® or 409® cleaner. WAIT for a few minutes then spray again. Allow time for the dirt to run off, if really dirty, spray again and WAIT. Wipe off the parts while still wet with paper towels. If things are still dirty spray again and wipe off with cloth towels using a bit of pressure. The hard to reach spots can be cleaned with a Q Tip® soaked in the cleaner. When your sure you have cleaned off everything, rinse with plain water and dry with a cloth towel. The plastic may have a gray appearance. Let the plastic parts dry.

For rinsing, I use a equal part mixture of plain water and rubbing alcohol, or with a little Windex.

Some dirt may appear to be imbedded into the surface, this may be true or it may be the plastic starting to break down. Spray some cleaner on a cloth towel and apply elbow grease with the towel this should work. I have had success with using rubbing compound sold by automotive stores, but this tends to scratch the surface a bit, it will buff out true hard bakelite. Plastic cases tend to be soft and easily scratched.

I have found that the oven cleaner may work to remove old paint spatters, but do a test spot first and read the precautions on the can.

Clean the contacts on the receiver and transmitter units, both on the units themselves and in the handset by using a Q Tip® dipped in ammonia, rinse it with a Q Tip® dipped in water and then dry the terminals. The ammonia will remove the tarnish from silver plated parts.

Cut some pieces of index card into 1/8 inch strips. Use this to clean the contacts on the hook switch and dial. Using a bit of pressure on the contact hold them closed and draw the card thru the contacts

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so the abrasive nature of the card removes the dirt. You will probably see a dark line that gradually goes away on the paper strip. You can then clean the contact with ammonia and repeat the index card cleaning. This will eliminate a lot of static because of dirty contacts.

Cleaning the dial is an operation in itself. Remove the finger wheel and dial plate. Using paper towels and lighter fluid, squirt the lighter fluid on the bearings and then soak it up with the paper towels. This will remove the old grease. Add a SMALL drop of light machine oil to the bearings. A slightly heavier oil or light grease would be better, but it is not easy to obtain. Regular bearing grease for cars is too heavy. Adjust the governor for 10 pulses per second, if you do not know how to adjust this type of governor it will take too long to explain here so hopefully it works fine. More difficult cases may need the spring to be wound up more. And yes if you take the dial apart too far, all the parts will fly out, you may loose some, and you will never get it back together. As a kid I took apart old wind up clocks and put them back together, you might try this first!

There is no good way to determine the speed of the dial so it operates at 10 Pulses per second, in the old days the central office had a dial up service that sent back a tone when it was at the right speed. Dials with 9.5 to 10.5 pulses per second were considered acceptable. When electronic offices came in a wider dial speed, mostly on the fast side was acceptable. The best way is just trial and error. Out of speed dials, too fast or too slow will dial wrong numbers or you will get a fast busy tone. Telephone companies still accept dial pulses. If you try to connect a rotary dial phone to a modern business phone system it probably will not see the dial pulses. A converter is available from www.sandman.com to allow you to use rotary dial phones on these systems.

You can now apply a good coat of paste wax, let it dry a bit and then polish with a soft cloth towel. This is about as good as your going to get, unless you resort to a buffing wheel.

☠ Chemicals used in the section are dangerous, read the warning labels!

Plastic Polish

Novus Polish can be used to polish plastic and Bakelite telephones. Check out their web site at http://www.novuspolish.com . Other companies sell the products in small quantities. Search on the internet for Novus Polish to find a dealer.

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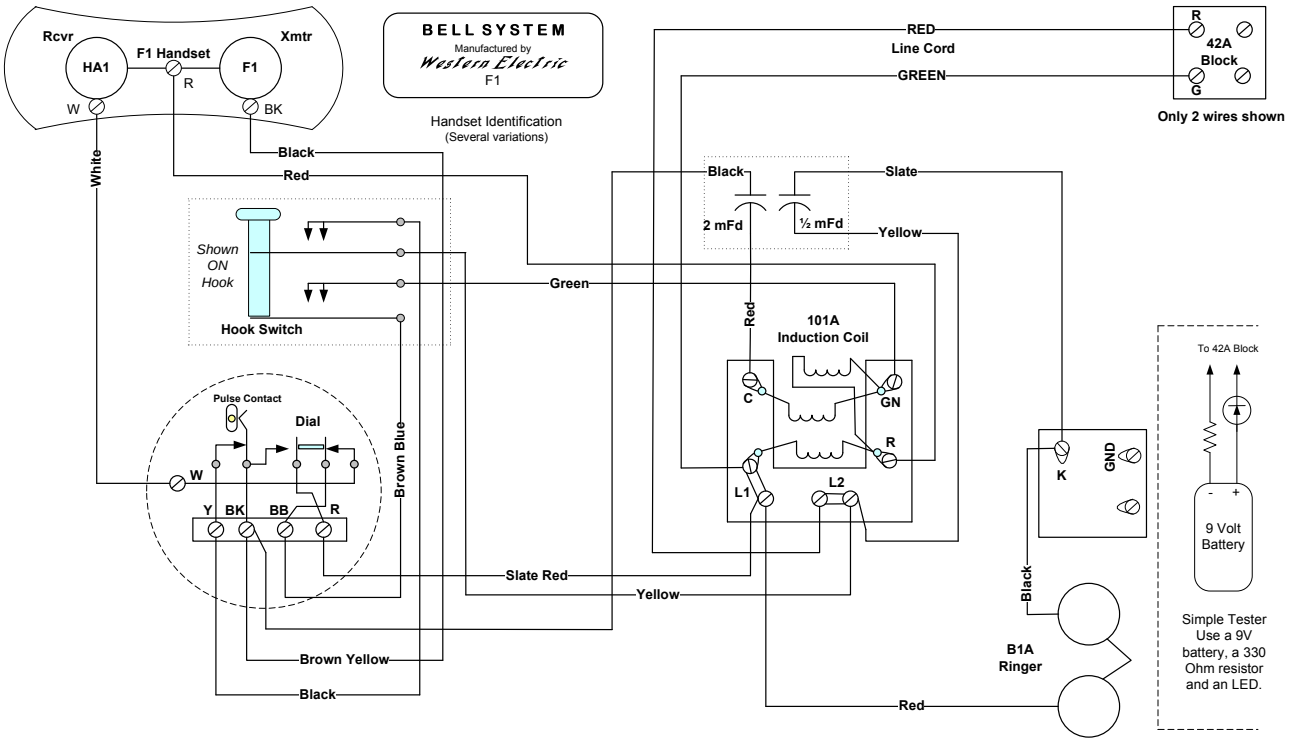
Western Electric® 302 Generic Diagram

This is a generic diagram, there were many variations. This one uses a 101A Induction Coil. The 101B Induction coil was used on a 2 party line, with a 3 coil ringer.



Western Electric 302 Telephone Set - Generic Diagram

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uc_older@yahoo.com

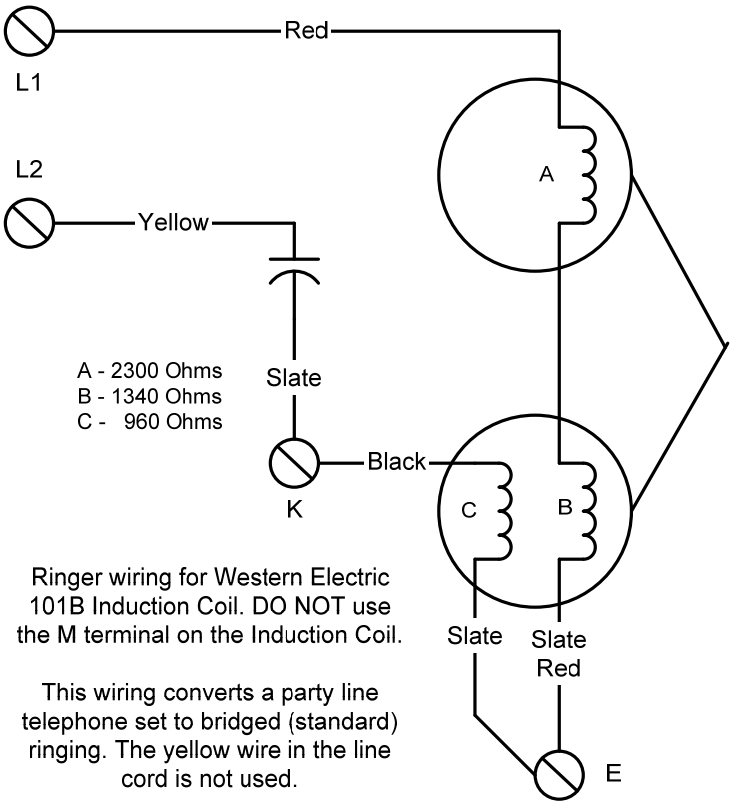
WE302GN2.vsd

A specific telephone type, such as this 302, has many variations, by the time you consider all the separate models, the variations, and the special modifications, you have hundreds of variations. This is true of all telephones. Diagrams can only be generic.

A Western Electric® 302 from eBay, could be some variation. Each telephone company had their own variations. Bell System companies used gas tube ringing, lift to talk on the hook switch, exclusion of a second telephone by lifting one side of the hook switch, two line switches, ringer on off switches, and many other variations. Several “non-Bell” companies used the basic telephone set and added their own handsets or dials.

If you get one of these sets, you can use this diagram as a wiring guide, and re-wire the phone to this diagram and it will work.

A 101B Induction Coil in your telephone was for Party Lines. The M is the mid-point tap, ignore it. There will be 4 leads on the ringer, rewire it as a standard ringer using the following diagram:



For other types of telephones, you may be able to find a diagram on the internet. If you have a set that requires a ringer box and you do not have the ringer box, try eBay for one. The problem with ringer boxes is that matching the ringer box to the telephone is not easy and can be expensive.

The best solution may be to use the test set diagram and just add the resistor/capacitor network. The phone will work and is usable, but it will not ring. Wire the dial pulse contact in series with the hook switch. There are too many variations of telephone sets to provide an exact diagram.

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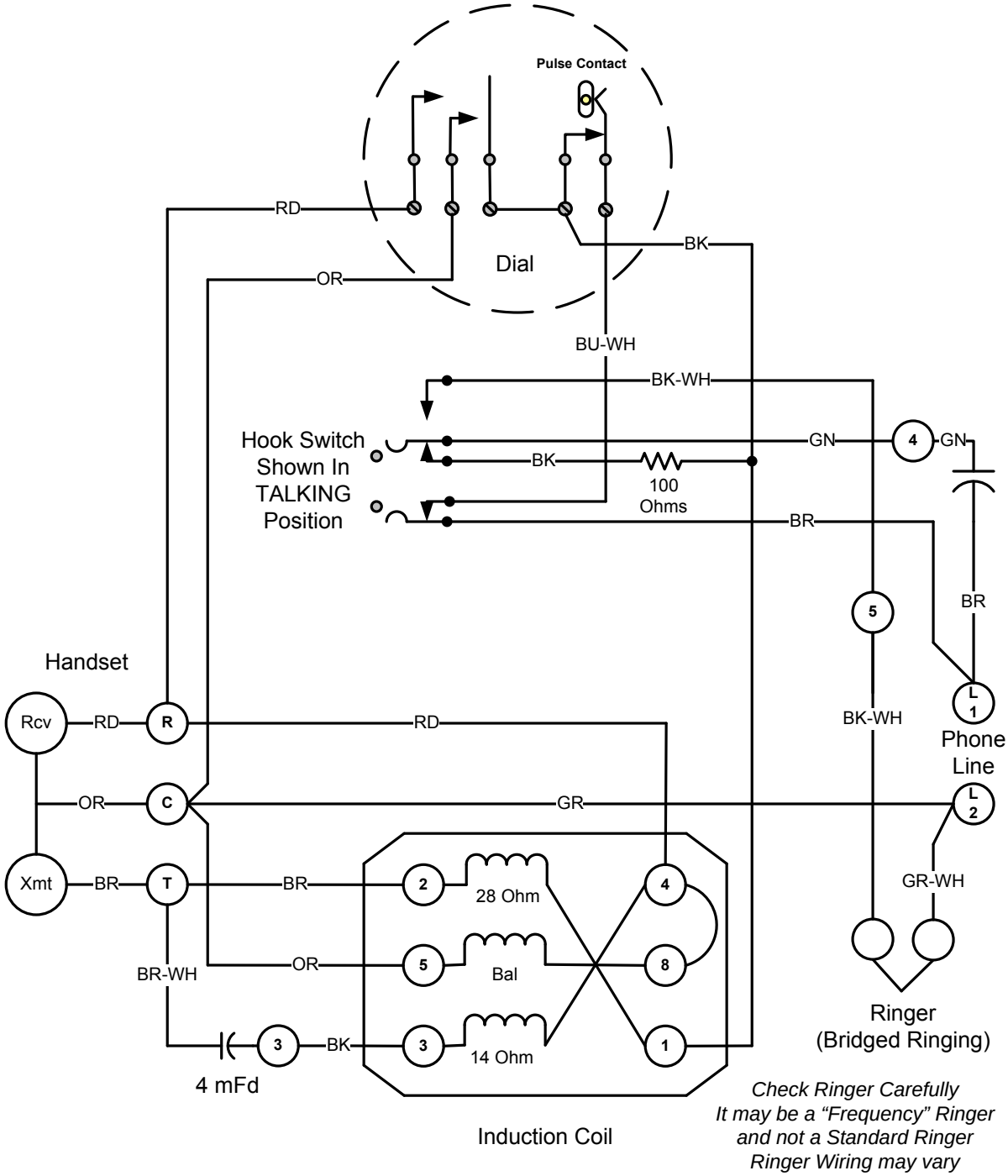
Automatic Electric – AE-40 – Wiring Diagram

This is a generic diagram, there were many variations. Many sets like this had a frequency ringer and not a standard ringer. If you have a frequency ringer it cannot be converted and should be disconnected.



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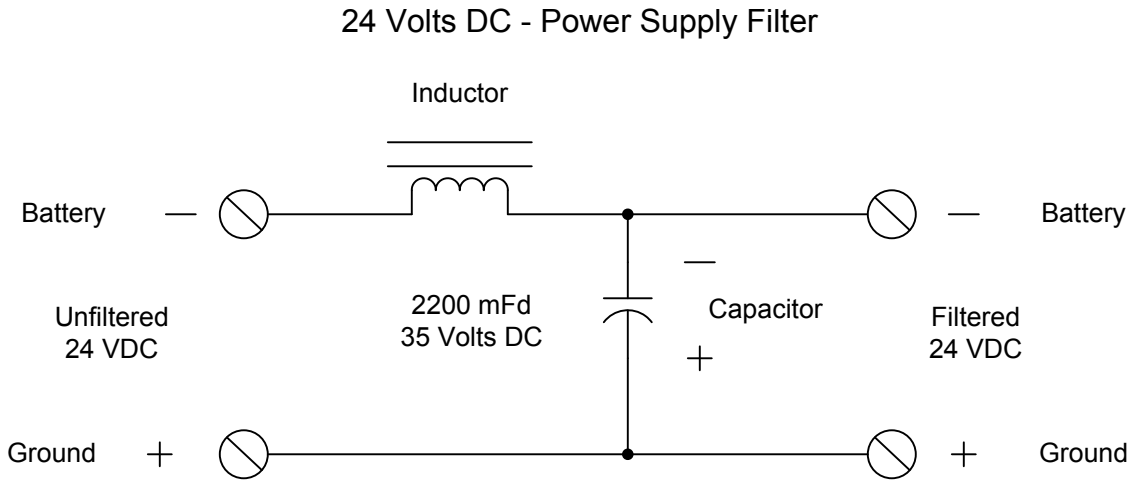
Adding a Power Supply Filter

In telephony a power supply filter is typically the old fashioned coil and capacitor. Electronic filters, i.e. 7824 or 7924 or similar circuits are not usually used. This is also called and LC filter and looks like this:



The trick here is to obtain the L or the inductor (choke). Power supply chokes suitable for this are not common. They should be rated at about 100 or 200 Milliamps (mA) and be of a low resistance, under 50 Ohms at most. Surplus electronic stores are your best hope. Substitutes are solenoids (yup, those with a good sized iron core and 50 Ohms or less) and are probably easier to find. Just tape the plunger or lever as if the solenoid were operated.

If you want to make your own filter choke, obtain a 70 Volt line speaker transformer (this is not a power transformer) rated at 10 Watts. Disassemble the transformer and remove the E's and I's of the core, you may loose a few as they are tightly packed but this does not matter. Re-assemble the core but do not interleave the E's and I's, keep them separate. Put all the E's in the core in one direction and then the I's, but put a sheet of paper, about ½ inch by 1 ½ inch (just a small rectangle of 20 lb printer paper) or so between them. You have now converted this to a "choke" and made a non-saturating core for use on DC. Re-assemble the transformer and use the highest resistance winding as your choke, tape and store the rest of the leads. As a simple alternative use a 12 or 24 Volt Solenoid, not one with a diode across it, and tape the plunger into the coil. Try for one with under 50 Ohms resistance. *Filters reduce hum.*

Telephone induction coils, the ones inside the telephone, use a non-saturating core design, look carefully to find the "gap" in the core. Very old induction coils were just wound over iron wire using straight pieces of wire about 4 inches for the core..

A non-saturating core is used to prevent the magnetic lines created when DC is applied to the coil from creating too many magnetic lines (consult the AT&T book)

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How to determine REN – Ringer Equivalence Number

Ringer Equivalence Number (REN) is very important. Too much ringer load on your home phone line and you will have problems. The total ringer load needs to be considered. Each “standard” telephone such as Western Electric® 500 or 2500 telephone set has a ringer load (REN) of 1.0. Some of these sets may have an FCC tag on the base showing the ringer load. Typically an answering machine is .5 REN. For example you have a living room phone, a kitchen phone, a bedroom phone and an answering machine, your total ringer load (REN) would be 3.5. You would be fine.

If you add an older telephone the ringer load could be as high as 2.5 (some old sets such as the oval base telephone sets with a ringer box or a candlestick with a ringer box). Your ringer load would be 5.5, too high. An option would be to disconnect some of the ringers (remove one of the ringer wires from the terminal where it is connected and tape and store it) or to change the REN of the old telephone. Too high an REN and your telephone line may ring once and stop and the Central Office will see trouble and you line will be on a “trouble list” with the telephone company knocking on your door

But, how do you know what the ringer load on the old telephone is? This circuit will help you determine that.

The way the tester works is the more the ringer load, higher REN, the brighter the light gets, this means less Voltage available for the ringer. The meter measures the Voltage across the ringer. You calibrate the meter using known ringer loads (standard telephone sets with an REN of1.0). You meter readings might look something like this:

Volts	Condition
101	No Ringer Connected
95	One Ringer – REN = 1.0
89	Two Ringers – REN = 2.0
81	Three Ringers – REN = 3.0

Don’t try to figure out a relationship between the numbers, just make a record of them and what number represents for a ringer load. Ideally, your old telephone set should never exceed an REN of 2.0, and preferably not over 1.5 REN (estimated by your meter reading).

When I restore a telephone, I usually try to make the ringer load as close to 1.0 as I can. Often I just substitute a new .47 mFd 250 Volt capacitor for the original ringing capacitor and re-adjust the gongs to give the best sound.

If you have an old telephone and you in doubt as to the REN, it is best to add the .47 mFd capacitor just to be sure. The simple way to do this is to remove ONE of the ringer wires from wherever it is connected and insert the .47 mFd capacitor by attaching one lead to the ringer lead and the other lead of the capacitor to the terminal from where you removed the original ringer lead. You may need to use a small machine screw, nut and washers if you have a spade tip lead on the ringer.

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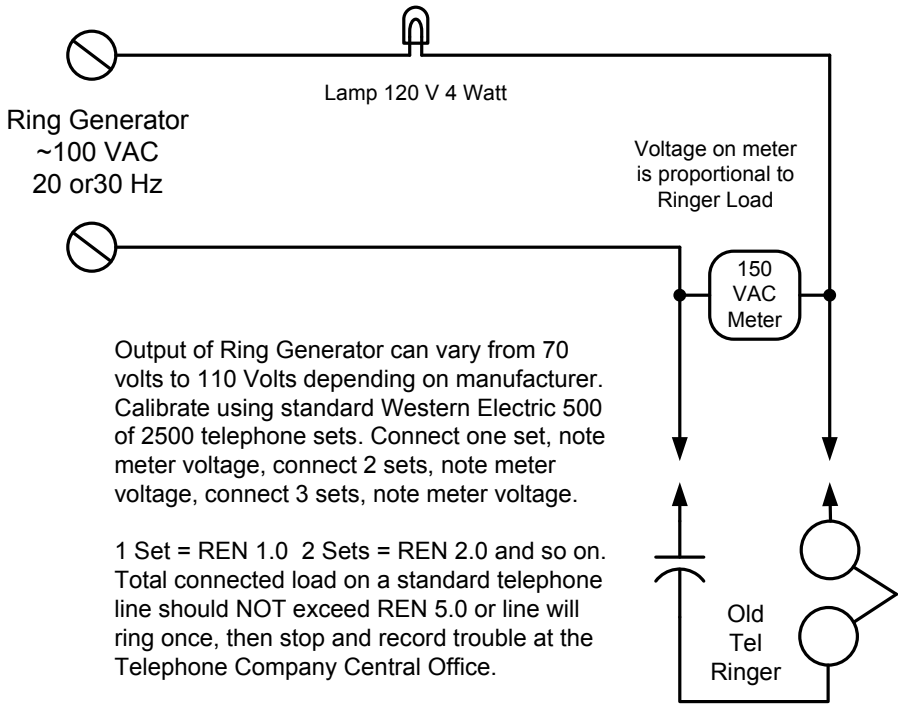
Determine REN - Ringer Equivalent Numbers


Lamp 120 V 4 Watt
Ring Generator
~100 VAC
20 or30 Hz
Voltage on meter
is proportional to
Ringer Load
150
VAC
Meter
Output of Ring Generator can vary from 70 volts to 110 Volts depending on manufacturer. Calibrate using standard Western Electric 500 of 2500 telephone sets. Connect one set, note meter voltage, connect 2 sets, note meter voltage, connect 3 sets, note meter voltage.
1 Set = REN 1.0 2 Sets = REN 2.0 and so on. Total connected load on a standard telephone line should NOT exceed REN 5.0 or line will ring once, then stop and record trouble at the Telephone Company Central Office.
Old
Tel
Ringer

The lamp is a night light replacement lamp. You may need to visit a large hardware store to find a base for it, or get a screw in adapter and use a standard lamp socket. Or, get the “import” lamp, it has a brass base and you can solder to it. The meter will cost about $15 (try http://www.allelectronics.com) and should not be too small to read the Voltages on the scale.

So what do you do if the old telephone you want to connect to the line has too high an REN? You have two choices, disconnect some of the bells in your existing telephones so as not to exceed and REN of 5.0, or, modify the old telephone set to reduce the ringer load.

Using Magic Test Lead C, the standard ringer capacitor of .47 mFd, remove one wire of the old telephone set bell, attach one end of the test lead to the ringer wire and the other end of the test lead to the connection where you removed the ringer lead from. Re-test and determine REN, it will be less. You may need to adjust the gongs or the ringer spring to get the maximum volume out of the ringer. If this is satisfactory, obtain another capacitor and install it in the old telephone.

You may see an FCC Registration Tag with REN for Type A and Type B, don’t let this concern you. Type A is 20 Hz and Type B is for using the telephone on different ringing frequencies.

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Extras to Add to Your Tester

If you would like improve your tester and want it super professional, thing of these additions:

- Add a pilot light on your power supply for the DC and the AC (Neon Lamp w/resistor)
- Add a DPDT switch to reverse the line, tip to ring and ring to tip, to see if the phone is polarity sensitive
- Use two 12 Volt relays on the 24 Volt design, or two 24 Volt relays on a 48 Volt design, to provide a balanced battery feed circuit like the real thing, you may need to add a resistor or adjust the relay springs to get 35 mA thru the telephone set. Also a second capacitor between the two test lines will be needed.
- A ringing tone generator to provide real ringing tone into the 2500 good set.
- Replace the 24 Volt power supply with a 48 Volt one, use two 24 Volt relays and get a true representation of a telephone central office, and add a repeat coil (600/600 ohm transformer) between the two lines
- Replace the 30 Hz generator with one that puts out 20 Hz
- Put two terminals on the ring generator and ask your friends to put their fingers on them, but be sure to warn them they are going to get the shock of their life (see Caution Notes, and this is not suggested, just in case you thought of it!)
- Add “line loss” between the two telephone sets for a really true test, look up the line constants for 5 miles of 26 gauge subscriber cable (about 400 Ohms, .082 MFd and .9 mH per loop mile)

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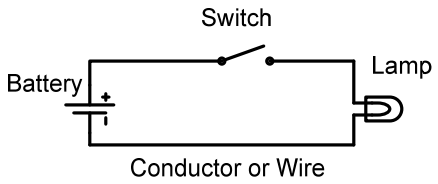
From the Ground Up – Basic Electricity

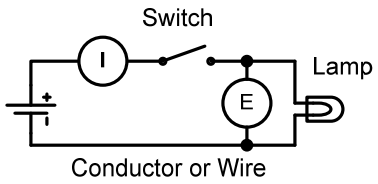
This section will explain telephones, electronic theory, and start you on the path to construction of the controller. It is long, detailed, and may be difficult reading for some. This is only a very brief introduction, read the ATT book listed in Section Three for greater deail.

Basic Circuit

To start with a bit of electrical theory, the basic circuit, this consists of a battery, a switch and a lamp:



Close the switch, or make the contact, and the lamp lights. There are two factors to consider here, the Voltage and the current. E is the Voltage (E stands for Electro Motive Force) and I is the current (I stands for the Intensity of the current flow). A break in the wire or dirt on the switch contacts will not complete the circuit and the lamp will not light.



In the case of our simple circuit, I used a D cell and a flashlight bulb. E is 1.5 Volts and I is .2 Amp (or 200 Milliamps – 1 Amp is 1000 Milliamps). The power of the bulb can be determined, 1.5 Volts times .2 Amps is .3 Watts. Power = Volts X Current or in Ohm's Law P=IE. (In Ohm's Law, Voltage is E, Current is I, Resistance is R and in Watt's Law, Power is P)

> *Wiring diagrams are just mechanical pictures. Learning to read them takes a little practice, that's what pencils and little bits of masking tape are for. With a printed copy of a diagram and pencil and tape, make lines on the drawing and use bits of tape to identify parts and wires. Your newly built LED tester will show you if your have a connection. Trace everything in your phone, learn the parts and the connections.*

The Telephone Central Office and Telephone Line

In telephone work, the battery is in the Central Office and the switch is the hook switch in the telephone and the lamp is the telephone circuit. We have another factor to consider, the telephone line is long and has resistance to the flow of electricity. This is the diagram of a circuit for a telephone line.

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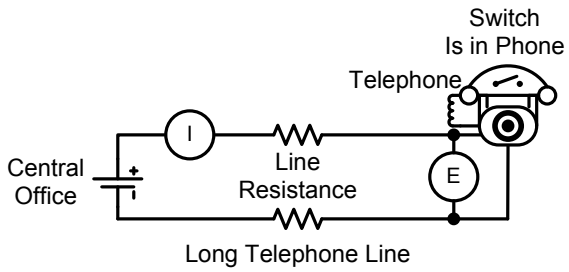

This looks like the basic circuit of the battery, wire, switch, and lamp. The Central Office battery is 48 Volts, and the line resistance varies depending on how far away you are from the Central Office plus some resistance in the circuits of the central office. Typical Resistance values are: (Resistance is measured in Ohms)

400 Central Office Equipment
866 2 Miles of telephone cable
200 Resistance in the telephone

Adding this up (resistances in series add) you get 1,466 Ohms. If you measured the current in the telephone line it would be about .032 Amp or 32 Milliamps. The greater the distance from the Central Office, the less the current. If the current falls below about 24 Milliamps, things do not work well.

When the telephone is in use, the Voltage across the telephone will be about 7 Volts, this can vary depending on the type of telephone. The Voltage will also vary depending one line resistance.

In the design of the telephone line simulator and power supply shown in this book, the resistance value of the relay, resistor, and telephone add up to about 1,000 Ohms. The Voltage of the power supply is about 30 Volts, resulting in about .03 Amps or 30 milliamps. Current = Voltage/Resistance or in Ohm's Law, I=E/R

Resistance values of the telephone vary depending on the type of telephone and the type of network. Modern networks contain devices that compensate for the distance from the Central Office so the volume is the same regardless of the length of the telephone line or distance from the Central Office, up to the office limit or the maximum allowed miles of wire.

What's Inside the Phone?

The next diagram is the simplified schematic of a modern standard rotary dial telephone. I have simplified the "network" or "induction coil" and it is not the standard anti-sidetone circuit but is functionally equivalent. Not shown are the varistors in the modern network that compensate for the line current to average out the volume.

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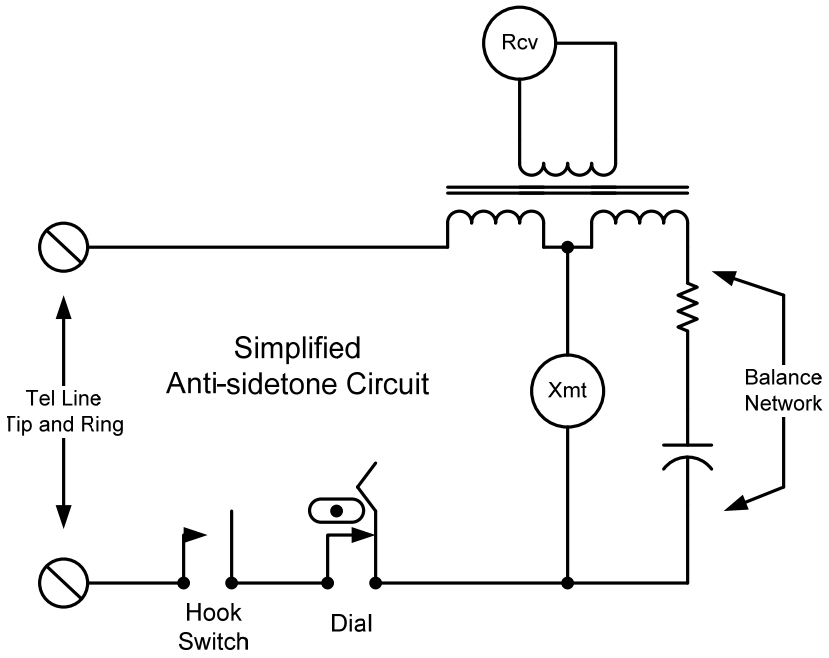
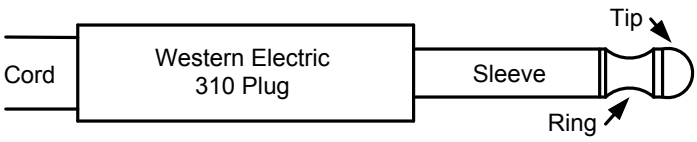


The polarity of the telephone line, tip and ring, is not important. The hook switch is shown in the open (handset on hook) position. Not all switch and dial contacts are shown.

I have shown a simplified anti-sidetone circuit, while fully functional, it is not the standard network, I have also left out hook switch contacts and dial contacts that shunt or open the receiver to prevent dial pulse clicks.

Tip and Ring

Tip, Ring and Sleeve are terms that come from the plug used on old switchboards. These plugs are similar to design of stereo headset plugs. The Tip and Ring are the Telephone Line and the sleeve is the control lead in the Central Office.



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Telephone Circuits and Anti-Sidetone

Over the years there have been a number of different induction coils for telephones. They have evolved into Integrated Circuits that simulate the induction coils of the past. The Western Electric 302, using the 101A or 101B Induction Coil and Capacitor or the Automatic Electric AE-40 began the modern era of Anti-Sidetone Circuits. This later developed into the Western Electric 425B Automatic Self Compensating Anti-Sidetone circuit and the companion circuit in the AE-80.

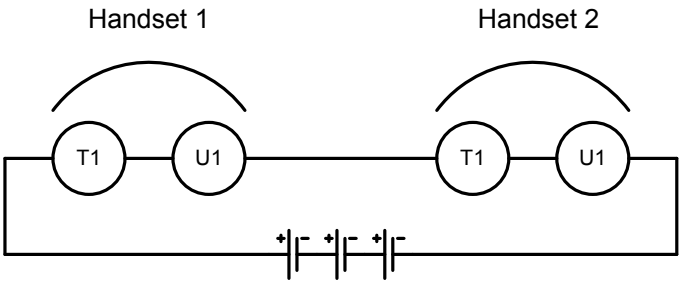
Sidetone is the “hearing” of your voice when you speak into the telephone. If you hear your voice too loud then you will speak too softly. To get you to speak up, this sidetone is reduced, so you only hear your voice a little, that way you know the phone is working. Anti-sidetone is the reducing of your voice in your ear to encourage you to speak in a normal volume. This is accomplished by a transformer that will “cancel” part of your voice.

Automatic Self Compensating Networks, like the 425B, also regulate the amount of line current in the transmitter which makes the volume of your voice, that is transmitted to the distant party, constant. If you are close to the Central Office the line current is higher, if you are far away, the line current is less. A varistor across the telephone line in the 425B shunts (or absorbs) excess line current if you are close to the Central Office. A second varistor in the “line balance” part of the network changes the impedance of the telephone set to match the impedance of the telephone line and is also dependent on the distance you are from the Central Office.

It would be easier if you understood a little telephone theory before going forward. The easiest way to do this is to read a basic electronics book or one of the suggested books listed in the other sections of this book. But, knowing that you are probably not going to do that, just ignore this paragraph.

Lets start with a simple telephone circuit. If you try this at home, you will need to remove the click suppressor from the back of the receiver, if you use a modern handset. These are Western Electric G handsets, the T1 is the transmitter and the U1 is the receiver.

Circuit One - The basic talk circuit for two people:



Battery 4.5 Volts
3 “D” Batteries

All components in this circuit are in series. This works quite well, but there is no signaling, and no way to notify the other person that you want to talk. You can add more handsets, if the volume is weak then add more batteries. Not too practical, but it does work.

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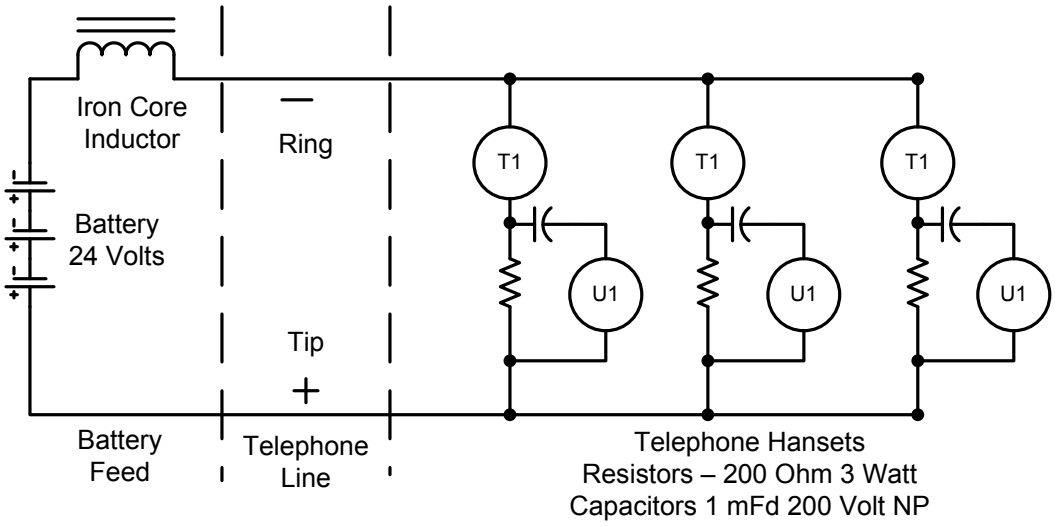
Circuit Two – The basic battery feed circuit



The Iron Core Inductor is a coil of wire around a piece of iron. It should have about 200 Ohms of resistance. This will allow 120 Milliamps or mA (0.12 Amps) of current to flow if you short circuit the telephone line. With three “handsets” connected this is about 35 Ma of current per handset, more than adequate.

If you want to try this at home, use the primary winding (120 Volts) of a small 12 Volt, 1 or 2 Amp transformer as your inductor. You are just using the transformer as a coil of wire on an iron core. You can add several more handsets.

The coil of wire has both resistance (DC Resistance easily measured with an ohm meter) and Inductance or Impedance (AC Resistance). The impedance keeps the “voice” on the phone line and does not allow it to “short out” as the battery has a low resistance. Typically, a battery feed coil provides about 3,000 Ohms or more of Impedance.

Circuit Three – Understanding the Telephone Line

The telephone line, or cable between you and Central Office has certain characteristics. In telephone work we talk about a “loop mile” that is one mile of telephone cable, a pair of wires, from one point to another point.

Per loop mile the characteristics of a pair of wires, 26 gauge, are:

Resistance ----------	433 Ohms (Ω)
Capacitance ----------	.083 Microfarad (mFd)
Inductance ----------	.968 Millihenries (mH)
Impedance ----------	911 Ohms (Ω)
Loss ----------	2.89 Decibels (dB)

This is at 1,000 Hz or about the center of the voice band.

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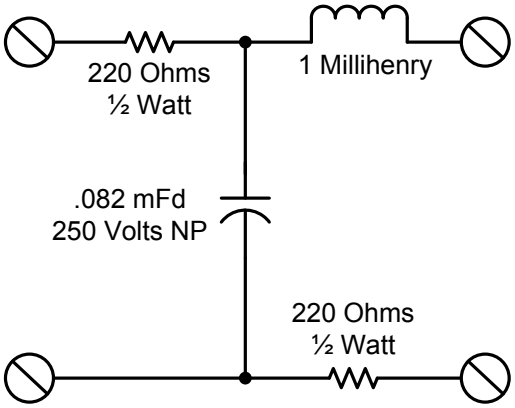
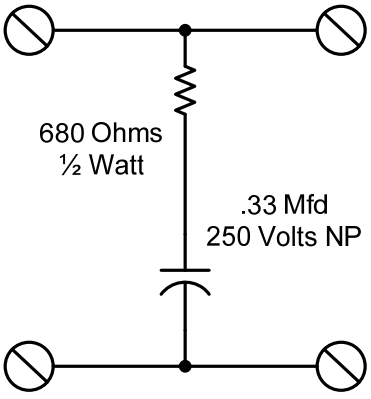
This is the electrical equivalent, using standard parts values. You could use this and build up one mile of cable or several miles of cable and put it in series with your telephone at home and see what happens.



The inductor is not necessary for voice circuit testing.

Circuit Four – Simplified 4 Miles of Cable

To simplify all this, and for the explanation of the anti-sidetone circuit we are going to use just a resistor and capacitor to simulate the line impedance and the line capacitance. The assumption is that you are 4 miles from the Central Office so this is the QD (Quick and Dirty) equivalent:



Values are standard easily obtainable parts. Try adding this across your phone line, see if the volume drops.

This is a circuit to simulate audio loss.

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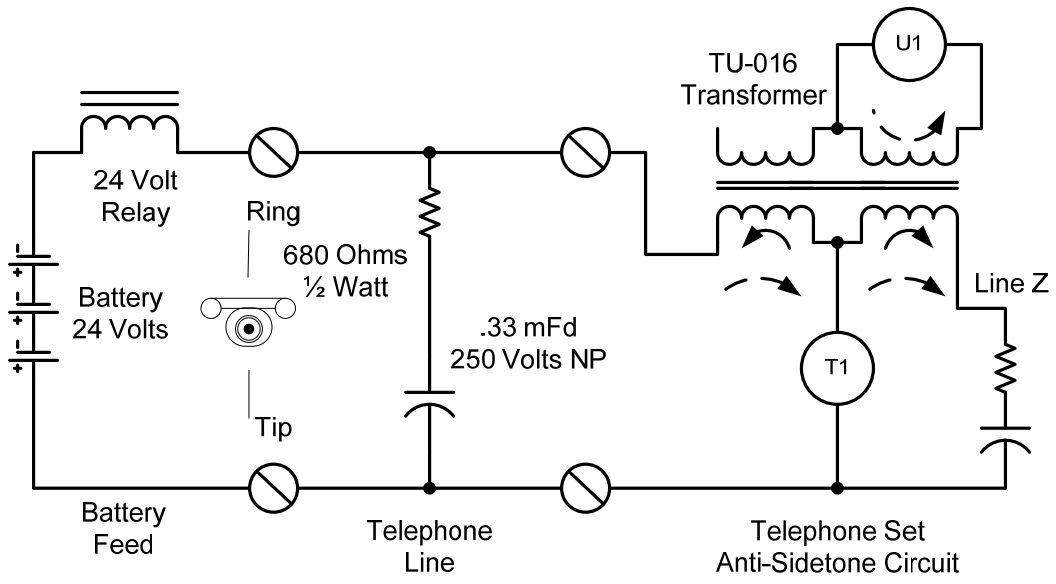
Circuit Five – Battery Feed and The Telephone Line With the Anti-Sidetone



Shown is a 24 Volt relay, usually about 700 Ohms of DC resistance. This will allow about 30 mA of current to flow (the resistance of the telephone is included when doing the calculation). The relay is a coil of wire over an iron core, so it has inductance and impedance.

For the explanation of this drawing consider there is a mirror circuit to the left of the drawing for the other telephone. The impedance of the telephone line is about 900 Ohms. The TU-016 is a commonly available part (Mouser Electronics) and is a 1:1 Transformer, 600 Ohms Center Tapped or 150 Ohms per coil.

The inbound voice flow (from the imaginary caller on the left of the diagram, has two paths, shown in the dashed lines). The first is in the left hand part of the transformer, going through the T1 (Transmitter) to the other side of the phone line. The second path is through the first winding (as in the previous statement) and in the right hand part of the transformer and the Line Z circuit. The Line Z is a resistor capacitor that is about the same value as our telephone line (.33 mFd and 680 Ohms). All of this flow results in a flow of the voice in the winding of the transformer connected to the U1 (Receiver). These flows are shown in dashed lines with an arrow.

When you talk into the T1, the voice has two paths to flow, one is the telephone line (and the caller on the left hand side of the diagram) and into the Line Z network. If the Line Z network is exactly equal to the values of the phone line, the .33 mFd and 680 Ohm resistor, the voice is cancelled in the transformer and nothing is heard in the receiver. This is shown with a solid line with an arrow.

In theory you should never hear your voice in your receiver when you talk. Getting an exact match, transformer and Line Z (impedance or the resistor capacitor simulation circuit) exactly equal to the telephone line impedance is rarely possible. You will hear some of your voice. This then becomes an anti-sidetone circuit. The volume of your voice is reduced so that you will speak at a normal volume as you only hear a little of your voice in your ear.

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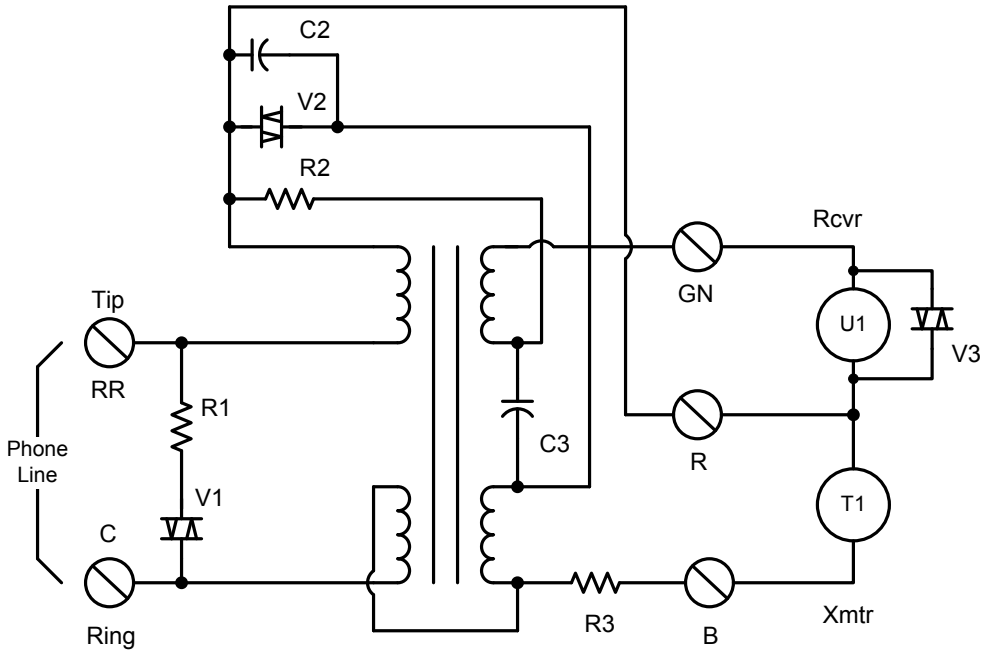
There are many variations of anti-sidetone circuits. Older telephones either did not have them or the circuits were not too effective. The Western Electric 302 telephone with the 101A Induction Coil and Capacitor and the Automatic AE-40 with the similar circuit are the more modern versions. Later versions, like the one that first appeared in the Western Electric 500 contained varistors, parts that compensated for the distance from the Central Office and "regulated" the volume so the telephone sounded the same if you were next door to the Central Office or several miles away.

Below is a diagram for a modern telephone, a Western Electric 500/2500. This is a simplified drawing, less the hook switch and dial. V1 and V2 are varistors, these change resistance depending the line current. V3 is a varistor across the receiver to prevent "clicks" or loud volume noise.



R1 and V1 compensate for the distance from the Central Office to regulate the "volume" and C2 and V2 are the compensation for the line impedance that varies slightly depending on distance.

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Build a 24 Volt Power Supply and Tester

There are Two Testers in this Series

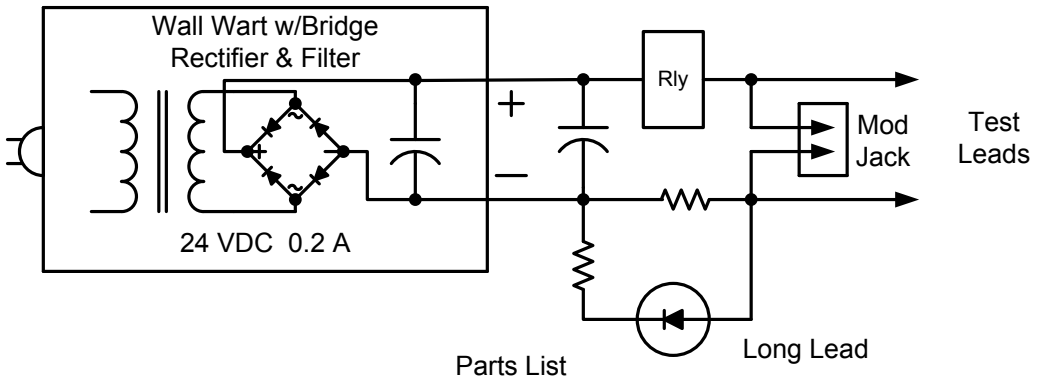
QD 1- The Simple Tester – 24 VDC Wall Wart
QD 2- The Two Line Tester – AC Wall Wart

If you do not want to go the trouble of hunting down a real telephone power supply you can build one of these using a simple wall transformer. These are the QD Circuits (Quick and Dirty).

QD 1- The Simple Tester – 24 VDC Wall Wart

This is the simplest tester. Find a wall transformer (Wall Wart) that has a DC output of 24 to 30 Volts DC. The current rating can be small, as little as 0.1 Amp. This is only for testing a single telephone without the use of a second telephone to determine quality.

Do not use a “switching” power supply, use one that contains a transformer (it may be hard to tell, but a switching supply is regulated and is lighter in weight).



Parts List

Wall Transformer 24-30 VDC
Relay – 650 or 700 Ohm 24 VDC
Capacitor – 1000 mFd 35 VDC
Resistors – 100 Ohm ½ Watt
LED – Any LED

An external capacitor, 1000 mFd 35 VDC, is added to reduce the hum, as most power supplies like this do not provide a lot of filtering for the power supply. Here is a picture of the final product, rather crude, but is works just fine and does the job.

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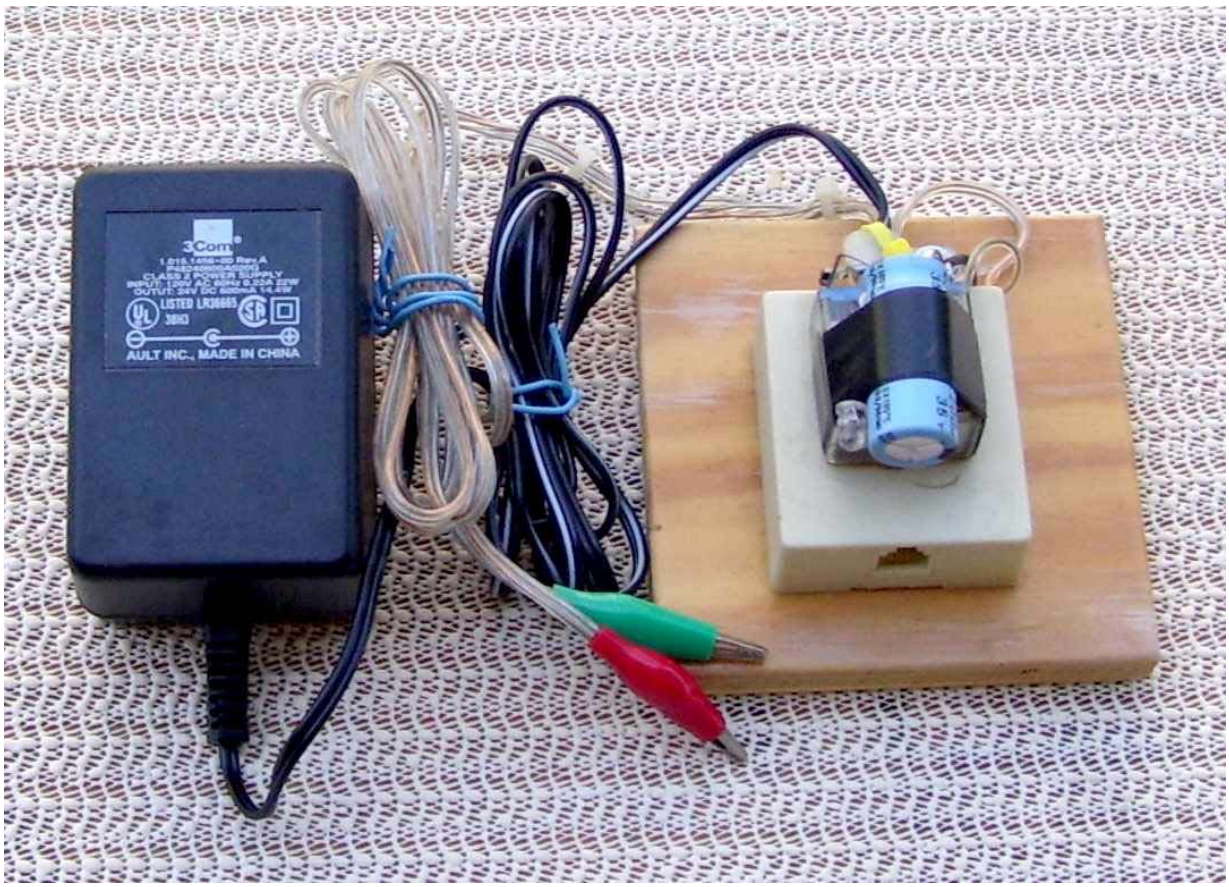

QD 1 Wall Wart 24 VDC

Clip leads were added, this way you can use either the jack if the phone has a modular cord, or the clip leads for an older telephone.

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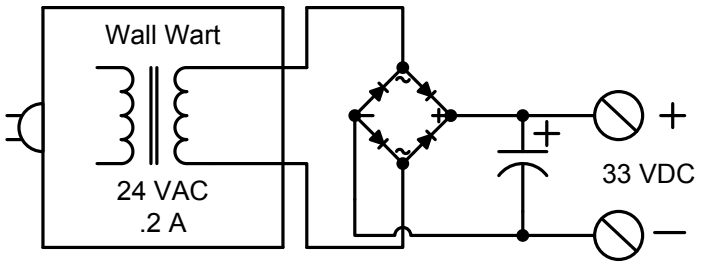
QD 2- The Two Line Tester – AC Wall Wart - Part One and Part Two

There are two parts to this, the power supply (shown next) and the battery feed circuit, you can build each in a separate case or combine them into one case. When I built mine I put it all in one case and used a compact jack with two separate jacks in one case.

If you are going to be doing a lot of testing and have several telephones you may want to build this tester. It uses a wall transformer rated at 24 Volts AC and 2 each 24 Volt relays and a few other parts.

This is the power supply:



Parts List

Wall Transformer – 24 VAC 0.2 Amp (or more)
Bridge Rectifier – 200 PRV 2 Amp or 4 ea
1N4004 Diodes wired for a bridge
Capacitor – 2200 mfd 50 or 63 Volts

If you find a 30 Volt DC wall transformer you can use that. A 24 Volt DC transformer will work and the telephone line current will be adequate for testing. Sources for surplus parts are listed in the Section Three. All Electronics or MPJA is your best source. Jameco charges a bit more.

Be careful and do not short circuit the output. You can add a 3300 Ohm resistor and an LED across the output if you like. This will show that you have power and will also discharge the capacitor when you unplug the power supply. This is also a crude method of construction, the parts are glued to the box with contact cement. When I closed the box I put electrical tape over the bridge rectifier. I added two binding posts for the DC output, just in case I wanted the DC to test something.

The second part is the battery feed circuit. This is the 24 Volt relays and jacks in one box.

[Schematics are shown separately, but are built in one box]

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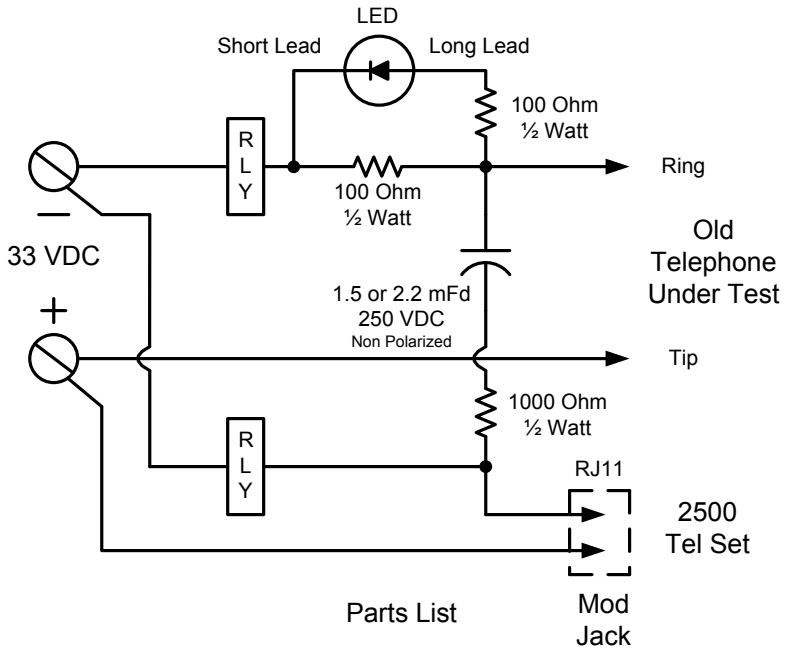
Schematic for 2 Battery Feed Circuits



Parts List

Relay – 24 VDC 650 or 700 Ohms
100 Ohm Resistors for LED
Capacitor – 1.5 or 2.0 Mfd 250 VNP
1000 Ohm Resistor

I have added a 1000 Ohm resistor in this version. This will simulate an actual telephone connection, phone A calling Phone B and some loss because of the distance of the telephone wire between the two phones. This is optional. If you have only a 1 mFd capacitors, you can use it, change the 1000 ohm resistor to 680 Ohms.

You may also add the LED Resistor combination to the telephone jack for the 2500 Tel Set if you want. I have two jacks on the sample and made up a “Test Cord”, just a mod cord with alligator clips on the end.

Use of the 24 VAC transformer, which will provide about 33 VDC, gives a bit higher line current as compared to the 24 VDC unit. The higher Voltage results in slightly higher line current and is better if you are going to test coin telephones as they require a bit higher line current for good operation.

The 24 VDC relay will not be harmed by operating on 33 VDC, the telephone set has some resistance so the relay will operate at 24 VDC with the rest of the Voltage found across the telephone line or phone under test.

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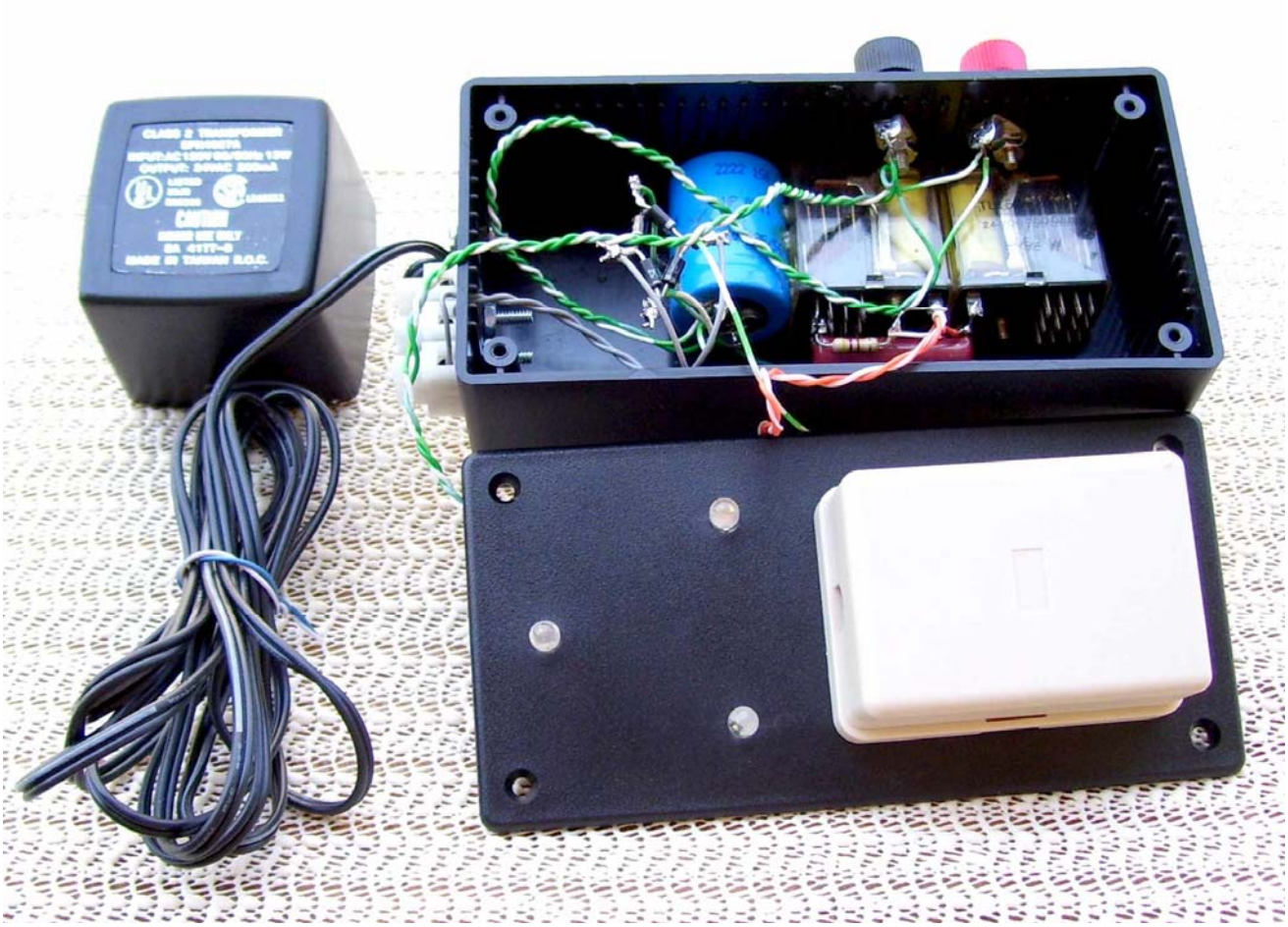
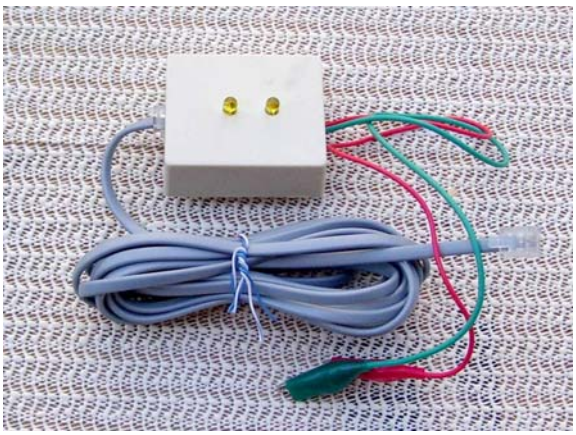


The White box on the cover is a 2 line Jack



The test cords in the above picture come in handy as not all old telephones have modular cords. The phone jack has the 100 Ohm resistors and 2 LED's in parallel so either polarity will light one of the LED's.

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Section Three – Reference Information

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Parts Sources and Links

This is only a partial list, check each site for links

The Bell System Memorial a very comprehensive web site and I suggest you order the CDs:

http://www.bellsystemmemorial.com

Telephone Collectors Sites: (Join them)

http://atcaonline.com
http://www.telephonecollectors.org
http://www.telephonearchive.com

Old Telephones Part Source:

http://www.phonecoinc.com

Another Telephone Parts Source is:

http://www.oldphoneman.com

Doing your own telephone station wiring:

http://www3.sympatico.ca/bparker/index1.html

http://www.ling.upenn.edu/~kurisuto/phone_wiring.html

Telephone Schematics and Diagrams:

http://www.geocities.com/CapeCanaveral/Campus/1491/
http://www.telephonecollectors.org/library/index.htm
http://www.atcaonline.com

Information from Canada (US & Canadian Phones):

http://www.islandregister.com/phones/phonelink.html

Text on Repair of Old Telephones:

http://www.ccamblab.com/old_tel/rpr_ot21.pdf

This is the manufacturer of the Black Magic series of 20 Hz ring generators for use in other equipment and also have a tech sheet on the main web page.

http://www.navysalvage.com

Helpful hints on telephone repair, they will also do it for you. Look at the links.

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General Tools and Modern Telephone Supplies:

http://www.sandman.com

Sandman also has a 20 Hz Ring Generator Kit, about $150 or less, and a nice automatic tester with 20 Hz ringing for about $300, take a look. Great on-line catalog.

http://www.greenlee.textron.com

Greenlee is a source for cable/tone testers

http://www.vikingelectronics.com

Business accessories and special telephones. 48 VDC, 20 Hz, Power supply.

Electronic Parts:

http://www.allelectronics.com

General electronic supplies, test leads, capacitors, relays, etc.

http://www.mpja.com (Recently added a cable tester/probe kit)

MPJA for general electronic supplies, test leads, capacitors, relays, etc.

Another page with hard to find information and links:

http://www.telephonetribute.com

I like the page http://www.telephonetribute.com/signal_and_circuit_conditions.htm which has all the sounds, like old dial tone.

Old Catalogs and BSP's (BSP is Bell System Practice)

http://www.telephonearchive.com

Many scanned documents and catalogs. Also a page of internet links.

Telecom General Information:

http://www.epanorama.net/links/telephone.html

Most of these sites have links to other sites, make use of the links. Links change and go away, search on Google.

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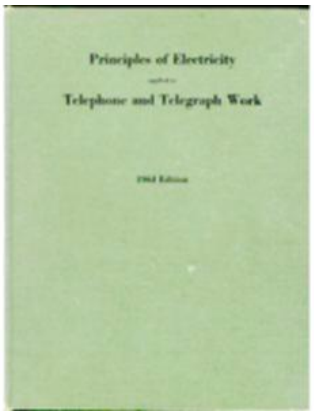
Books to Read

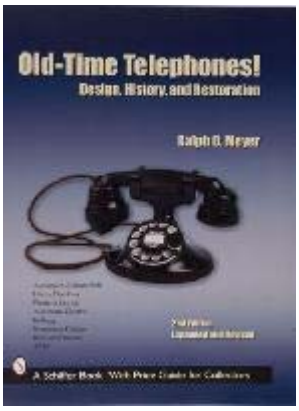
Principles of Electricity



Published by American Telephone and Telegraph. The last one issued in 1961. Older editions are more interesting. Often available on EBay for a nominal amount. The 1938 edition and the 1961 edition would make a good contrast. Excellent book on basic Telephony, but no information on switching or networks. Definitely worth reading again and again. This is a must have for future engineers!

Old telephone company employees refer to this as The Green Brain. On eBay for $12 or so.

Old Time Telephones



This is the second edition of this book

By Ralph Meyer, excellent book with lots of theory and wiring diagrams. Well worth the money. Go to www.schifferbooks.com and search by telephone, they have several books.

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Glossary

See an Electricity/Electronics Dictionary for explanation of terms not directly related to old telephones. Definitions here apply to the text in this book. This is a very brief list.

Automatic Electric – A telephone manufacturing company, part of General Telephone (Now Verizon). No longer an active company.

Battery – A source of DC (Direct Current). In a Central Office, Ring refers to the lead that is Negative, the Tip is the positive side of the battery and is grounded at the Central Office.

Bell System – A group of operating telephone companies owned whole or in part by American Telephone and Telegraph... oh well it gets very complicated as companies have split and then merged again.

Capacitor – Passes AC (Alternating Current) and blocks DC (Direct Current). Value is in Microfarad, mFd.

Central Office – Provides battery and ringing for a common battery telephone and switching (dialing) of telephone parties.

Click Suppressor – Used in modern telephones to reduce the volume of “click” in the receiver, often added to old telephones which have very loud clicks in the receiver.

Common Battery Telephone – A telephone set that gets the power from the Central Office.

Handset – Combines the transmitter and receiver into one hand held unit.

Induction Coil – The name for the transformer used in a telephone set.

LED – Light Emitting Diode. A solid state device, a silicon junction, that emits light of a specific color when an electric current passes thru it.

Local Battery Telephone – A telephone set that gets the power from batteries located at the telephone set.

Northern Electric – The equivalent of Western Electric in Canada. At one time a percentage of the stock was owned by Western Electric.

Ohm’s Law – The relationship between Voltage (E), Current (I) and Resistance (R). Watt’s Law adds Power (P) into this.

Receiver – Changes AC (Alternating Current) into sound waves.

Relay – An electric switch, application of electricity to a coil of wire makes a magnet and a lever operates a switch. The coil of wire on the relay has resistance and inductance.

Resistor – An electrical device that opposes (but does not slow down) the flow of electric current by limiting the amount of current that can flow. Value is in Ohms.

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Ring- The Negative side of the telephone line. (see Tip)

Ringer – Changes electrical energy into mechanical energy. Consists of a electromagnet, a clapper and two gongs. Works only on AC (Alternating Current), isolated from the DC on the telephone line by means of a capacitor.

Ringer Capacitor – The standard value is .47 mFd rated at 250 Volts. This is for an un-tuned ringer.

Rotary Dial – A “round” dial that you put your finger and move the dial in a circle so when it returns it interrupts the current flow once for each digit dialed.

Schematic Drawing – An electrical drawing that uses special symbols for the parts.

Spade Tip – Use on telephone wires to provide for a connection to a screw terminal.

Telephone – An electro-mechanical device used to communicate by sound over a pair of wires. Invented by Alexander Graham Bell and improved by others.

Tinsel Wire – Flat wire wrapped around a cloth core and with a cloth covering used for flexible wire on telephone cords.

Tip – The Positive side of the telephone line. (see Ring)

Touch Tone® Dial – A registered trade mark of AT&T for a dual tone push button dial that generates 2 tones for each number.

Transmitter – Changes sound waves into electrical signals. In an old telephone a Carbon Transmitter is used, the resistance varies with the frequency of the sound and the loudness. Invented by Thomas Edison.

Tuned Ringer – A ringer that responds only to a specific ringing frequency. Also called a Frequency Ringer.

Wall Wart – Small power supply that plugs directly into a wall outlet.

Western Electric – The manufacturing part of American Telephone and Telegraph. They manufactured a wide variety of equipment, not just telephones. No longer an active company.

Wiring Diagram – An electrical drawing that used pictures of the parts and shows the wires as lines.

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Notes on This Publication

My Picture
Note Evil Grin – Taken in China 2006

Colin T. Chambers

That's me… I started in the world of telephones when I was about 11 years old. Two old telephones, some wire and a few #6 dry cells to set up a telephone link between two groups of friends. That was in 1954. In 1958 I did a traffic study of the traffic in my Central Office (step-by-step). One thing leads to another, college, public school teacher, and …. In 2003, I left IBM as a Telecommunications Network Design Engineer. I have done it all and know it all. If you say E1 to me, I can tell you about an E1 handset from the 1930's or an E1 carrier (2.048 Mega Bits/Second). Don't get me started!

DISCLAIMERS

Ringing Generators and Telephone Lines produce Voltages that can cause an electrical shock. Wet hands, standing in water or on a wet ground can increase the intensity of the shock. Your reaction to this shock could cause you to fall or move into something that could harm you.

Old telephones may have one side of the telephone line connect to the metal parts of the telephone, this could be dangerous and result in a shock.

Anything suggested in the book should only be attempted if you feel confident in avoiding electrical shock and in taking the necessary precautions to work safely and to produce a restored telephone that is free of electrical hazards.

Use caution when working with chemicals to clean an old telephone.

Thanks to my editor, Brian Jester, for improving on my bad written English.

All rights reserved, all this is my own work, so don't make copies of it, I really did file for a copyright.

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